Series 1954, No. 1

Issued August 1958

SOIL SURVEY

Fillmore County Minnesota

OUR SOIL ★ OUR STRENGTH

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
MINNESOTA AGRICULTURAL EXPERIMENT STATION

How to Use THE SOIL SURVEY REPORT

THIS SURVEY of Fillmore County will help you plan the kind of farming that will protect your soils and provide good yields. It describes the soils, shows their location on a map, and tells what they will do under different kinds of management.

Find Your Farm on the Map

In using this survey, start with the soil map, which consists of the 72 sheets bound in the back of this report. These sheets, if laid together, make a large photographic map of the county as it looks from an airplane. Woods, fields, roads, rivers, and many other landmarks can be seen on this map.

To find a farm on the large map, use the index to map sheets. This is a small map of the county on which numbered rectangles have been drawn. Each rectangle corresponds to a sheet of the large map.

Suppose you have found on your farm an area marked with the symbol Fa. You learn the name of the soil this symbol represents by looking at the map legend. The symbol Fa identifies Fayette silt loam, 0 to 1 percent slopes.

Learn About the Soils on Your Farm

Fayette silt loam, 0 to 1 percent slopes, and all the other soils mapped are described in the section, Soil Descriptions. Soil scientists walked over the fields and through the woodlands. They dug holes and examined surface soils and subsoils; measured slopes with a hand level; noted differences in growth of crops, weeds, brush, or trees; and, in fact, recorded all the things about the soils that they believed might affect their suitability for farming. They also mapped the soils.

After they mapped and studied the soils, the scientists judged what use and management each soil should have, and then they placed it in a capability unit. A capability unit is a group of similar soils that need and respond to about the same kind of management.

Fayette silt loam, 0 to 1 percent slopes, is in capability unit 1. Turn to the section, Use, Management, and Productivity of Soils, and read what is said about soils of capability unit 1. You will want to study the table which tells you how much you can expect to harvest from Fayette silt loam, 0 to 1 percent slopes, under two levels of management.

Make a Farm Plan

For the soils on your farm, compare your yields and farm practices with those given in this report. Look at your fields for signs of runoff and erosion. Then decide whether or not you need to change your methods. The choice, of course, must be yours. This survey will aid you in planning new methods, but it is not a plan of management for your farm or any other farm in the county.

If you find that you need help in farm planning, consult the local representative of the Soil Conservation Service or the county agricultural agent. Members of your State experiment staff and others familiar with farming in your county will also be glad to help you.

Fieldwork for this survey was completed in 1954. Unless otherwise specifically mentioned, all statements in this report refer to conditions in the county at that time.

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Contents

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SOIL SURVEY OF FILLMORE COUNTY, MINNESOTA

Soil Survey by D. A. COWLES, J. F. GABIOU, G. F. HARMS, J. E. KUBIER, G. F. SICKLER, and G. A. SIMPSON, Soil Conservation Service, and H. F. ARNEMAN, R. S. FARNHAM, L. D. HANSON, L. C. LAMISON, and GEORGE WHALEN, Minnesota Agricultural Experiment Station

Report by R. S. FARNHAM, Soil Conservation Service, and Minnesota Agricultural Experiment Station

Correlation by Guy D. Smith, Soil Conservation Service

United States Department of Agriculture in cooperation with the Minnesota Agricultural Experiment Station

General Nature of the County

Location and Extent

FILLMORE COUNTY is in southeastern Minnesota. It is bounded on the south by the State of Iowa, on the north by Olmstead and Winona Counties, on the west by Mower County, and on the east by Houston County (fig. 1). Preston, the county seat, is almost in the geographical center of the county. The county has an approximate area of 859 square miles. It extends about 36 miles from east to west and 24 miles north from the Iowa border.

Physiography, Relief, and Drainage

Fillmore County is a gently rolling or rolling upland plain, deeply dissected in places by stream valleys. The eastern half is characterized by a succession of narrow gently rolling or rolling divides, which are the remains of an old geologic plain (Dodgeville peneplain). Between these divides is an intricate pattern of deep valleys and ravines that have steep slopes and precipitous rocky bluffs, in many places, 50 to 500 feet high.

The Root River and its tributaries and many small intermittent streams in narrow valleys have steep rocky bluffs along their entire course (fig. 2). Somewhat extensive terraces, many in step formation, occupy different levels in the valleys of the Root River and its larger tributaries. Many valley slopes are steep and rocky; divides between them are comparatively smooth. The highest points on these divides have approximately the same altitude. A relatively smooth area, originally covered by prairie grasses, is in Bristol, Harmony, Canton, and Newburg Townships in the southern part of the county. This extensive area is on the broad divides that separate the watersheds of the Root River and the Upper Iowa River. Some terraces occur adjacent to streams in the glacial drift region, particularly along the Upper Iowa River on the Iowa border.

The western half of the county is a gently rolling drift plain, only slightly dissected by streams. Within this area, however, are a few narrow, deeply cut val-

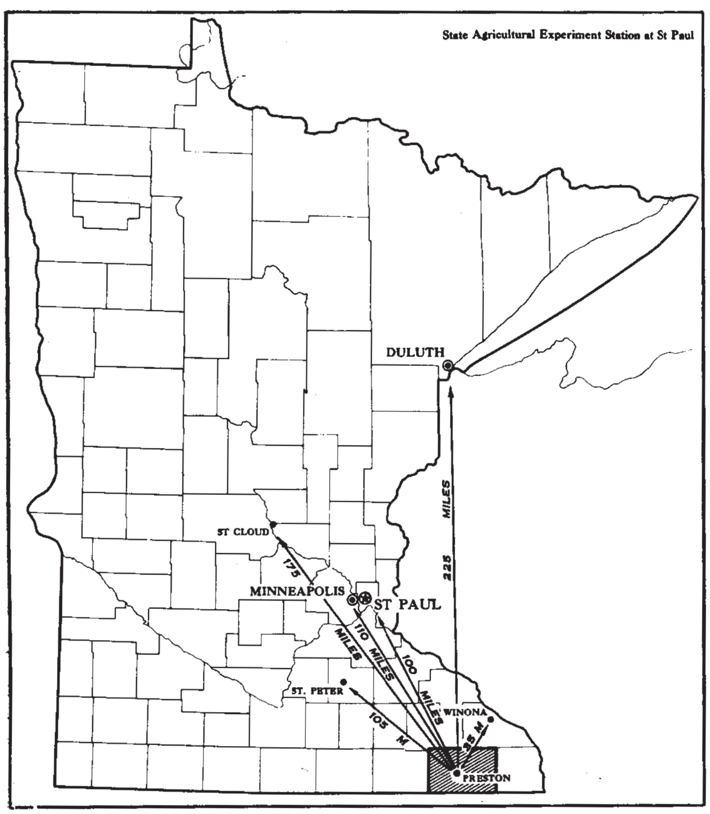

Figure 1.—Location of Fillmore County in Minnesota.

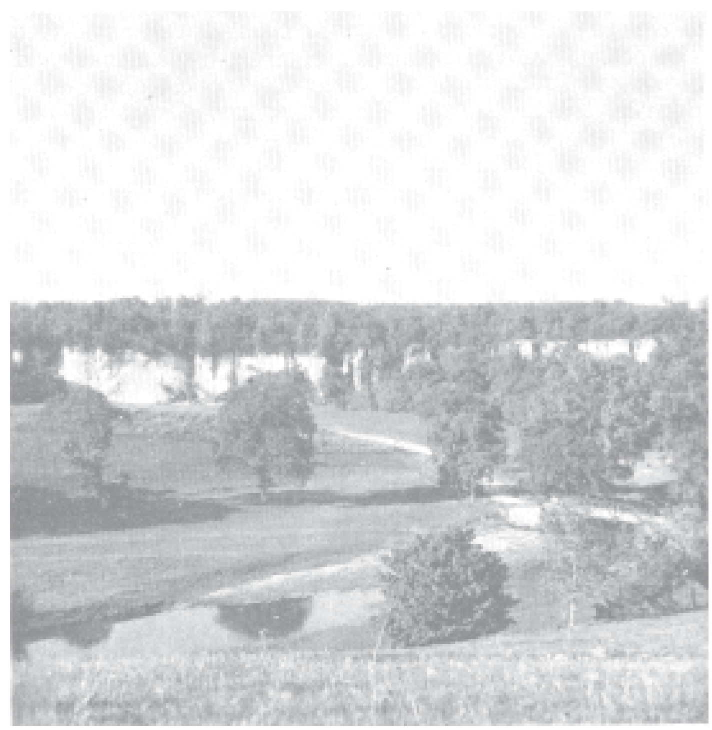

Figure 2.—Narrow valleys and limestone bluffs are typical of the highly dissected areas of the county.

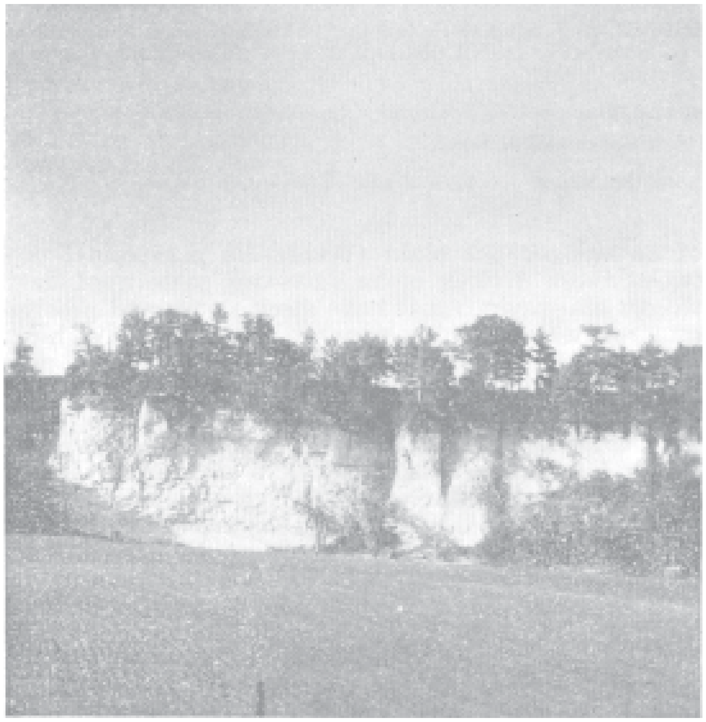

Figure 3.—**Limestone bluffs in the western part of the county.**

leys (fig. 3). In the extreme northwest and southwest, on the broad divides between streams, the relief is level and smooth because of the leveling and filling action of glaciers. Extensive flats and large poorly drained depressions are common.

Except for level areas in the glaciated section, the drainage of the county is dendritic and well developed. The county is drained almost entirely by the eastward-flowing tributaries of the Root River. Exceptions are Beaver, York, Bristol, Harmony, and Canton Townships, where a few small valleys are drained by the Upper Iowa River.

Many of the tributaries originate on fairly smooth glacial drift plains in the counties to the west and north. Inside the county line, they enter narrow valleys, continue through deeply cut rock valleys, converge near the main valley, and leave the county in one volume near Rushford in the northeastern corner. The South Branch of the Root River, rising in Mower County, enters Fillmore County just north of the village of Ostrander in Bloomfield Township. In its eastward course, it crosses Forestville, Carimona, Preston, and Carrolton Townships, and it joins the Root River in Holt Township. The river flows on through Arendahl and Rushford Townships. From Mower County to Houston County, a distance of more than 36 miles, the river descends from an elevation of slightly more than 1,200 feet to about 700 feet.

Many small tributary streams are fed by springs, but surface water often drains into sinks or sinkholes and thence to underground drainage channels. Many sinkholes occur in lines on the uplands and increase in number and size near large valleys. Underground passages connect many of them, and in places subterranean gorges can be traced several miles by a succession of large sinkholes. Bear Creek, in Jordan Township, and Kedron Creek, in Sumner, both flow underground for several miles. Canfield Creek, south of Forestville, flows underground about 12 miles. The South Branch sinks in the northeast quarter of section 19, in Forestville Township, and flows underground, except at times of high water, to about the center of section 21.

Geology

The soils and land types of Fillmore County have formed largely in the deposits laid down by wind, water, and ice during the glacial period (Pleistocene). An extensive mantle of loess, ranging from a few inches to more than 20 feet deep, was deposited by wind during the retreat of the Iowan glacier. It covers about three-fourths of the county east of the Iowan glacial border. The loess-covered area resembles the large driftless area, but it shows evidence of having been covered with ice during the glacial period. This part of the county has been thoroughly dissected through long-continued and uninterrupted erosion. This came about because of differential weathering, uninterrupted by glaciation, of the underlying alternate layers of hard limestone and friable sandstone. On the steep valley slopes, particularly in the larger valleys, where geologic erosion has been active, the bedrock is exposed or the mantle of loess is thin.

Glacial drift deposits of the Iowan age cover more than half the western part of the county. The entire county was glaciated, but thick deposits of drift are confined to eight townships in the extreme western part of the county. Eastward from the thick Iowan drift area, the glacial deposits are thin. In some places the deposits occur in preglacial valleys and as a thin mantle on the divides.

Terraces of the Root River valley consist of stratified gravel, sand, and silt. In the glacial drift area, the terraces consist of glaciofluvial deposits left by melt waters from the waning glaciers.

Limestones, sandstones, a few beds of soft shale, and other geologic formations that underlie the loess and glacial drift are a succession of sedimentary rocks of the Central Lowland physiographic division. Limestones form the most prominent feature of the landscape. Most outcrops are limestone, and they project along the summits of the bluffs and constitute the escarpments of benches or terraces (see fig. 3).

The soft and crumbly sandstone outcrops are much less spectacular, but they are, nevertheless, conspicuous. They commonly occur below limestone exposures on steep slopes, and are, in many places, covered with a thin layer of loess.

Green shale deposits lie between two layers of hard limestone on prominent benches on the uplands. They are characterized by many springs and wet spots.

The deep valleys of the Root River and its fanlike tributaries show exposures of many different sedimentary rock formations. Along the Mower County line near Ostrander, the South Branch of the Root River flows on glacial drift and Cretaceous gravels of the

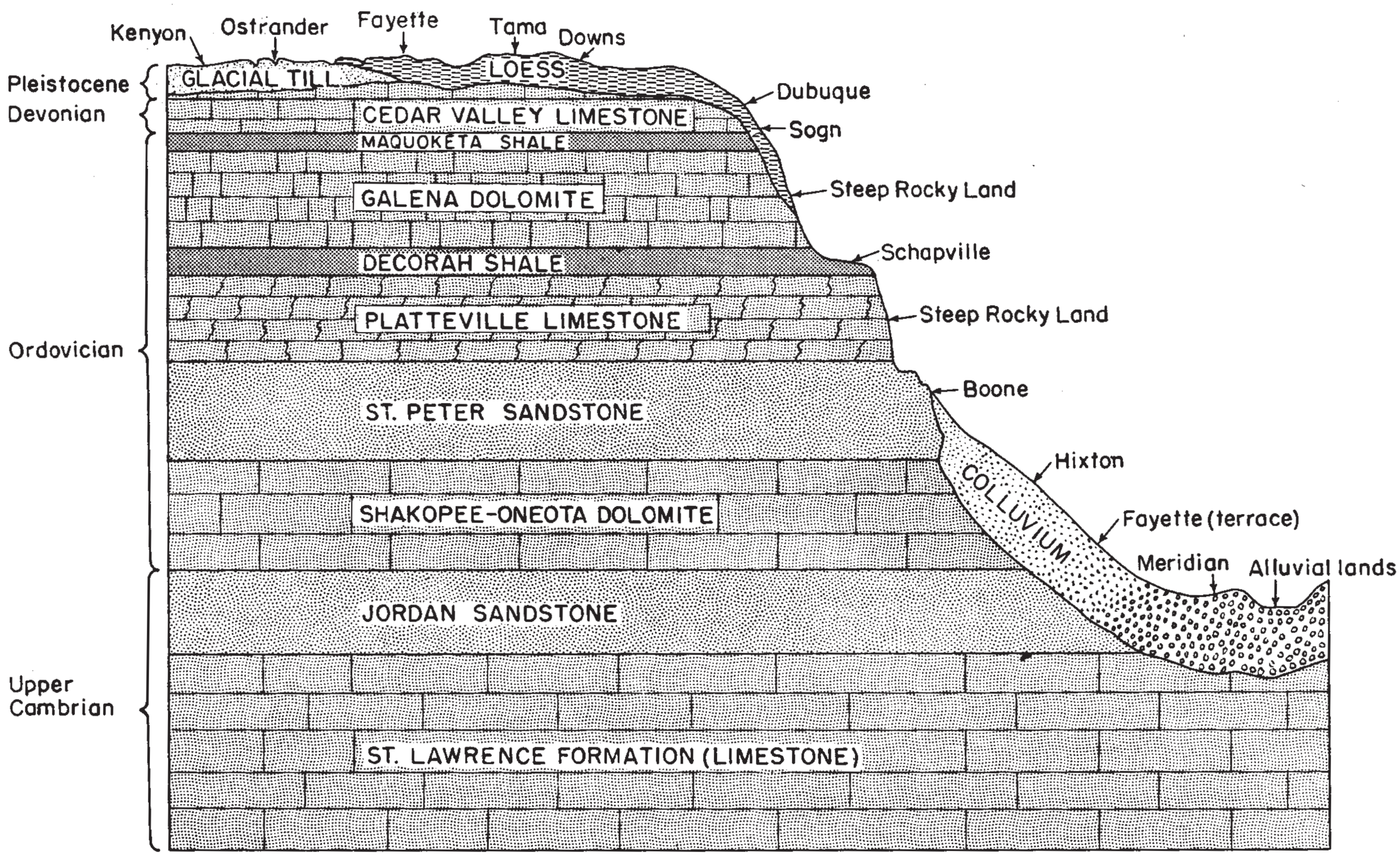

***Figure 4.*—Schematic diagram of a cross section of a valley showing geologic formations and some of the principal soil series and miscellaneous land types.**

Ostrander member[1] of the Dakota formation. Cedar Valley limestone is exposed in a few places. Eastward, at Preston, the stream has cut through several strata of limestone, sandstone, and shale, including the Galena dolomite, Decorah shale, Platteville limestone, St. Peter sandstone, and Shakopee and Oneota dolomite, and the stream bed lies slightly above the Jordan sandstone. Farther downstream, at Rushford, the river has cut through the Jordan sandstone, and the valley floor rests on older rocks of the St. Lawrence formation, which in some places contains patches of glauconite (greensand).

The river, as it leaves the county, winds through a wide, rockbound, alluvial valley more than 2 miles wide, that lies 500 feet below the tops of the bluffs. In its eastward course, the river successively descends through formations of the Cretaceous, Devonian, and Ordovician periods, and its bed rests upon Upper Cambrian deposits.

Figure 4 shows a cross section of the geological formations of Fillmore County. It reveals the nearly horizontal layers of limestone, sandstone, and shale. This idealized diagram shows the occurrence of the various rock formations at different places in the county along the Root River. For convenience of illustration, the vertical scale and, hence, steepness of slopes, is greatly exaggerated. Some rock formations are limited to certain parts of the county and are, of course, discontinuous. Others, particularly the older nearly horizontally bedded limestones and sandstones, are continuous and underlie the entire county. Except for occasional remnants, geologic erosion has, in places, removed some of the younger bedrock formations. Residues of soft shale resting on limestone occur in isolated spots throughout the county.

Where the soils are underlain by the very soluble Galena limestone, there are many sinkholes and depressions. They are most numerous where the Galena dolomite occurs directly below the thin drift or loess mantle. Underground waters have dissolved most of the upper part of the rock, leaving it porous and cavernous, and the thin surface has collapsed to form sinkholes. Many sinkholes occur in a northwest-southeast diagonal zone, where much of the drainage is through underground channels.

Some large channels have formed huge caves, such as Niagra Cave near Harmony and Mystery Cave southwest of Wykoff.

Beds of impervious shale (Decorah shale), which prevent downward infiltration of the water, lie directly beneath Galena dolomite. The water held in the beds dissolves the limestone, and underground passages and caverns are formed. Many springs and wet spots occur where the shale outcrops.

[1] Thiel, George A. GEOLOGY AND UNDERGROUND WATERS OF SOUTHERN MINNESOTA. Minn. Geol. Surv. Bul. 31, p. 77. 1956.

The town of Spring Valley rests on beds of Maquoketa shale. This shale is fairly impervious and produces many springs near the town.

The municipal water supply of Lanesboro, in the valley of the Root River, formerly was obtained from large springs issuing from deep sandstone formations. Deep-lying sedimentary rocks produce many large springs in this locality.

Climate

Fillmore County has a typical continental climate characterized by wide variations in temperature, scanty winter precipitation, normally ample summer rainfall, and a general tendency to extremes. Table 1 gives the normal monthly, seasonal, and annual temperatures and precipitation at Grand Meadow Weather Station, Minn., 4 miles west of the Fillmore County border. The records of this station, in Mower County, are used because records of the three weather stations in Fillmore County are incomplete.

The seasonal variation in temperatures is great. The average annual temperature is 43.7° F. January, the coldest month, has an average temperature of 12.5°, and July, the warmest month, has an average temperature of 71.6°. The lowest temperature recorded was –39°, and the highest was 107°. The difference between the average winter and summer temperatures is 53.7° F.

TABLE 1.—*Normal temperature and precipitation at Grand Meadow, Mower County, Minn.*

[Elevation, 1,338 feet]

Month	Temperature [1]			Precipitation [2]			
	Average	Absolute maximum	Absolute minimum	Average	Driest year (1910)	Wettest year (1911)	Average snowfall
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December	18.6	60	–30	1.18	0.40	3.15	8.9
January	12.5	57	–39	1.04	2.17	1.09	9.6
February	15.6	60	–36	.99	.17	1.45	7.9
Winter	15.6	60	–39	3.21	2.74	5.69	26.4
March	28.8	84	–25	1.70	(3)	.60	9.3
April	44.6	89	3	2.53	.43	2.44	3.0
May	56.4	107	20	4.33	3.70	6.57	.1
Spring	43.3	107	–25	8.56	4.13	9.61	12.4
June	67.6	105	32	4.83	.05	3.83	0
July	71.6	107	37	3.62	.76	4.62	0
August	68.8	102	33	3.51	3.53	13.34	0
Summer	69.3	107	32	11.96	4.34	21.79	0
September	60.4	100	22	3.81	4.43	4.58	.1
October	47.7	91	–5	2.38	.83	8.22	.7
November	31.8	78	–22	1.57	.44	1.64	4.8
Fall	46.6	100	–22	7.76	5.70	14.44	5.6
Year	43.7	107	–39	31.49	16.91	51.53	44.4

[1] Average temperature through 1955 based on a 69-year record; highest and lowest temperatures through 1952 based on a 66-year record.

[2] Average precipitation through 1955 based on a 70-year record; wettest and driest years based on a 68-year record, in the period 1886–1955; snowfall through 1952 based on a 63-year record.

[3] Trace.

In Fillmore County, severe winter temperatures are less important than the length of the growing season. The average date of the last killing frost is May 13, and the first in fall is September 27. This is an average frost-free period of 137 days.

The annual precipitation is less important than its distribution throughout the year. Fortunately, precipitation is highest during the growing season. The average annual precipitation of 31.49 inches is distributed as follows: Winter, 3.21 inches; spring, 8.56 inches; summer, 11.96 inches; and fall, 7.76 inches. Although in 1955 the precipitation was only 18.8, the driest year on record was 1910, with a precipitation of only 16.91. In 1911, the wettest year, the precipitation was 51.53 inches.

June is normally the wettest month—a distinct advantage to the growth of corn and other crops. Midsummer droughts lasting 3 or more weeks are not uncommon. Spring-planted small grains sometimes fail to mature because of dry weather in midsummer. The yield of corn also is reduced if drought continues during the growing season. Normally, rainfall is right for good yields on most soils. Drought causes complete crop failure only rarely.

Thunderstorms supply most of the rain in the warm months. The county is in the southeastern part of the State, where there is an average of 37 thunderstorms a year. At least one damaging rainstorm comes in summer. Tornadoes and ice storms occur occasionally. In May 1953, a very destructive tornado swept across the county, damaged crops and farm buildings, and caused the death of several people.

The average annual snowfall is 44.4 inches. The ground is usually covered all winter with snow, which protects meadows and fall-planted grains. Occasionally winters are unseasonably mild, have less than normal snowfall, and are marked by alternate periods of freezing and thawing. Vegetation is damaged during these winters.

The prevailing wind is from the northwest for 8 months of the year. Wind comes from the south in May and September and from the southwest in July and August.

Native Vegetation

Fillmore County is in the broad ecological tension zone where the western prairie and the eastern forest regions converge. A considerable part of the county was originally forested. Only a small percentage is now wooded. Most of the trees grow along drainageways and steep rocky slopes and bluffs. The trees are of two forest types—mixed hardwoods, and oak.

In the mixed hardwoods forest, more than half the stand is composed principally of maple, basswood, and elm. Ironwood, ash, aspen, butternut, white oak, hickory, redcedar, cherry, and black walnut, named in order of their importance, make up the rest of the stand.

In the oak forest, about 45 percent of the stand is red oak, 20 percent white oak, and 35 percent mixed hardwoods.

Originally the glaciated area in the extreme western part of the county and the broad divides in the more dissected sections were either partially forested or were open prairies. The partly forested areas (oak openings) also contained shrubs and grasses. The original vegetation on the open prairies was predominantly tall prairie grasses. Sloughgrasses and sedges still occupy many poorly drained depressions.

The relationship between soil type and vegetation is difficult to determine because few areas are in a virgin state. No undisturbed areas of open prairie have been observed. Evidence of trees encroaching upon the prairie is common, particularly along streams and drainageways. In other places, there are indications that prairie grasses have encroached upon the forests. The processes of encroachment are not entirely clear. It is apparent, however, that they were very complex and that their effect on the soils has been extremely variable.

In 1882 N. H. Winchell[2] emphasized the effect of prairie fires on plant succession. He reported that in the area covered by native timber, the timber was steadily increasing, and after prairie fires had destroyed the original prairie vegetation, willow, hazel brush, oak, and aspen, in turn, gradually became established. In time, brush or timber supplanted the prairie grasses. This is reflected in the soil profiles in some places. Soils of the prairie-forest border area have many characteristics commonly associated with true Prairie soils that have been modified, to some extent, by the presence of trees.

Environment affects vegetation. Prairie grasses commonly occupy the dry south slopes in the valleys, whereas mixed hardwoods grow on the cool, moist north slopes. Redcedar generally grows on steep talus slopes below outcrops of limestone or on very shallow soils overlying limestone bedrock. This lime-loving species is conspicuous on the steep valley slopes. It is a reasonably accurate indicator of the presence of limestone. Pines and other conifers were never widespread, but some used to grow on the dry sandy soils. Elm, ash, and maple of a swamp-forest association grow on upland flats in the somewhat poorly drained glaciated section.

The extent to which vegetation influences soil formation varies with the type of vegetation. Prairie grasses, in general, help maintain a high base status, promote aggregation, and intensify the dark color of soils through increasing the organic-matter content. On the other hand, the deep-rooted trees promote acidity but have little effect on aggregation. They increase the leaching action and thereby decrease the organic-matter content and give the soils light-colored surface layers.

[2] Winchell, N. H. GEOLOGICAL AND NATURAL HISTORY SURVEY, v. 1, Univ. Minn. 1872–82.

History and Development of Fillmore County

Settlement and Population

Fillmore County was established March 5, 1853, and named for Millard Fillmore, President of the United States from 1850 to 1853.

Many early settlers were from the East, and names of townships and villages reflect the settlers' origin. Such names as Amherst, Chatfield, Canton, Canfield, Bristol, and Bloomfield suggest the East. Other names are Indian, Scandinavian, or are those of early settlers and local streams.

Preston, in the center of the county, has been the county seat since 1856. It was first settled in 1853 and was organized on May 11, 1858. It was named by an early founder and mill owner, Luther Preston. He was appointed the first postmaster.

Spring Valley Township and village were settled in 1852 and 1855, respectively. A mile east of the village is a spring, and two others are within the township limits. One of them is walled up and pumped for the waterworks.

Lanesboro, a railway village in Carrolton Township, was plotted in the spring of 1868. Some of its early settlers came from Lanesboro Township in Berkshire County, Mass. F. A. Lane was one of the stockholders in the townsite company.

Rushford, settled in July 1853, and organized May 11, 1858, was named on Christmas Day, 1854, by unanimous vote of the pioneer settlers. The settlement was named from Rush Creek.

Chatfield, settled in 1853, and organized in 1858, was named in honor of Judge Andrew Gould Chatfield, associate justice of the Supreme Court of the Minnesota Territory, 1853–57.

In 1950 the larger centers of population were the following: Spring Valley, 2,467; Preston, 1,399; Rushford, 1,270; Chatfield (part), 1,118; Lanesboro, 1,100; Harmony, 1,022; and Mabel, 788.

Agriculture

Fillmore County is in the dairy and livestock region of southeastern Minnesota. The area of the county is 549,760 acres, of which 510,614 is classified as land in farms. The farms average about 165 acres in size, and more than three-fourths of them are operated by the owners.

A large part of the county is rough land. Most of the nontillable land is wooded, steep, or both, and is best suited to permanent pasture. Good drainage and lack of stones in the loess areas make it possible to cultivate most of the land that is not too steep.

The first settlers raised wheat, corn, barley, flax, rye, and oats. They kept cattle, horses, hogs, sheep, and dairy cows. The early settlers had several sawmills and a flour mill operated by waterpower. Wheat was their main source of income. Decreased yields, brought about by lack of soil fertility and damage by insects, diseases, and erosion, caused a change in farming after 1890. The farmers turned to raising livestock for market. Shortly after railroads reached the county, creameries were built and dairy farming became important. Meat-producing farms now outnumber the dairy farms, probably because one of the largest meat-packing plants in the Middle West is in Mower County. Poultry production is an important supplementary enterprise.

In the Federal census of agriculture for the 1954 crop year, the acreage of principal crops was reported for Fillmore County as follows:

	Acres
Corn, all purposes	102,551
Oats	76,120
Hay (excluding soybeans)	75,140
Alfalfa and alfalfa mixtures	42,299
Clover, timothy, and mixtures of clovers and grasses for hay	30,476
Other hay cut	2,365
Soybeans	16,096

For 1954, the Federal census reported livestock on farms and number of livestock sold as follows:

	Number on farms	*Number sold*
Cattle and calves	103,421	41,894
Hogs and pigs	143,062	137,624
Sheep and lambs	29,601	16,703
Chickens over 4 months old	504,103	261,029

In 1954, 42,226 gallons of milk were produced, 162,201 pounds of wool were shorn, and 4,300,873 dozen eggs were sold.

General Soil Patterns

The map of soil associations at the back of this report shows general patterns of soils in the county. It is useful for study of the soils in general. It is not detailed enough to plan practices on a farm. Each association contains several different soils, arranged in a characteristic pattern. The pattern in this county is related to the nature of the soil materials or the kind of vegetation. The eight associations recognized in Fillmore County are discussed in the following pages.

Light-Colored Soils Formed Chiefly on Silty Materials

Fayette, Dubuque, and Whalan.—This association, the largest in the county, occupies more than 40 percent of the area. Except for the western side, and the northwestern and southwestern corners, this association is well distributed throughout the county. The Fayette soils occupy mainly the loess-covered gently rounded ridgetops and adjacent slopes. Some terrace phases of Fayette soils are mapped near the larger streams. Dubuque soils occupy mainly the upper valley slopes along tributary streams. They have formed on thin wind-laid silt, which lies over bedrock. Whalan soils occupy nearly level to steep slopes near the breaks of rather high ridgetops or on narrow ridgetops. They have formed in a thin layer of glacial till that overlies bedrock. These soils are light colored, well drained to moderately well drained, and very erodible.

Chiefly dairying or general farming are practiced in this association. Most farms have some soils that are not too steep for row crops or small grains and a larger acreage of steeper soils well suited to pasture or to trees.

Dark-Colored Soils Formed Chiefly on Silty Materials

Tama, Downs, Rockton, and Dodgeville.—This association occupies slightly more than 16 percent of the county. It is distributed throughout the county, except for the extreme western side, northwestern corner, and southwestern corner. The Tama and Downs soils are the most extensive, but small areas of Rockton and Dodgeville soils and of Lindstrom soils are included in this association. Three-fourths of the soils occur on slopes of less than 7 percent. All of the soils are dark colored and well drained.

The Tama and Downs are deep soils that formed on loess. The Dodgeville soils are shallow. They have formed on loess overlying limestone. The Rockton are shallow soils that formed on glacial till overlying limestone. The dark-colored Lindstrom soils occur below wind-laid soils (chiefly Tama and Downs) or below soils formed on sandstone (Boone). They occupy gentle to steep valley slopes. Except for the steeper phases, the soils of this association are well suited to the general farming and dairying predominantly practiced in these areas.

A few hundred acres of Seaton and Port Byron soils are also included in this association. These soils were formed on deep loessal deposits that occur on isolated hills along the border of the wind-laid silts and glacial till deposits. These are silty soils that have little subsoil development. They are mapped as undifferentiated mapping units. The dark Port Byron soils are leached to depths of 30 to 50 inches. The Seaton soils are light colored and are leached to depths of 40 to 60 inches. Areas of less than 12-percent slopes are suited to row crops and small grains. Steeper areas are suited to pasture and hay.

Loamy and Silty Soils Formed Chiefly Under Forest or Forest and Grasses

Renova and Kasson.—About 6 percent of the county is in this soil association. It occurs within the glaciated area and is confined mainly to the northwestern, western, and southwestern parts of the county. The glaciated area has smoother topography than the areas of wind-laid soils. This association, however, occupies some of the steeper part of the glaciated area near streams. It lies near, or joins, another association that occurs within the glaciated area, that of the loamy and silty soils that formed chiefly under grasses.

The main included soils are members of the Renova, Kasson, and Skyberg series, all of which were formed on glacial till. The Renova soils are gently sloping to moderately steep, light colored, well drained, and rather low in fertility. The Skyberg soil is nearly level, moderately dark to dark, and poorly or imperfectly drained. It requires supplementary drainage to produce good crops. Kasson soils (particularly those on level areas) are somewhat slow to drain and to warm up in spring.

Except on the stronger slopes of the Renova soils that occur near streams and which are suited to pasture and trees, general farming is practiced in areas of this association.

Loamy and Silty Soils Formed Chiefly Under Grasses

Kenyon, Racine, and Ostrander.—This association covers about 10 percent of the county. It consists mainly of soils of the Kenyon, Racine, Ostrander, Floyd, and Clyde series. Very small areas of organic soils—Peat and Muck—are included. This association occupies mainly the western part of the county. In this area most slopes are long and gentle and some depressions occur. Few of the drainageways have distinct channels; interstream divides are broad and nearly level. Sinkholes are numerous.

Floyd and Clyde soils, mapped partially as an undifferentiated unit, are the most extensive in the association. The Clyde soils are black, highly fertile, and poorly drained. They occupy upland flats, depressions, and low areas along drainageways. The Floyd soil is very dark, highly fertile, and imperfectly drained. It has slightly better surface drainage than the Clyde soils.

The Racine and Ostrander soils, mapped as undifferentiated units, occupy higher areas and are well-drained soils. The dark-colored Ostrander soils have formed under prairie grasses, and the moderately dark Racine soils under the vegetation of the prairie-forest transition zone. All of these soils have formed mainly from glacial till or poorly sorted loess and glacial till, but alluvium and colluvium have influenced some of the Floyd and Clyde soils.

Dairying and general farming are the chief types of agriculture in this association.

Soils on Sandy or Gravelly Uplands

Chelsea, Boone, and Dickinson.—This association occurs in comparatively small areas, and few, if any, farms are entirely within it. The association consists mainly of Chelsea and Boone, Dickinson, Thurston and Wykoff, and Hixton soils. The Chelsea and Boone soils, mapped together as undifferentiated units, are mostly in the northeastern corner and the extreme western townships, mainly on slopes of 12 percent or more. They are light-colored sandy soils of low fertility that formed on residuum derived from sandstone or from sandy colluvium. They are not well suited to crops. Except on the gentler slopes, they are used mainly for pasture or trees.

The Dickinson soils are dark, of loamy or sandy texture, and have formed from sandy glacial drift. They occur mainly in the extreme west, northwest, and southwest in the glaciated part of the county. Most of them lie on knolls, low ridges, or low hills. The Dickinson soils are underlain by sandy materials and are droughty and moderately fertile.

The dark-colored Thurston soils that developed under grass and the light-colored Wykoff soils that developed under forest occur adjacent to or near the Dickinson soils and on similar slopes. They are generally more droughty than the Dickinson soils. The Thurston and Wykoff soils are underlain by gravelly or fine cobbly materials. Except on the stronger slopes, these soils are used for general farm crops. In most years crops are damaged by drought.

The Hixton soils occur close to the Chelsea and Boone soils and on similar slopes. They are sandy soils that have formed on mixed loess and residuum derived from sandstones and shales.

Soils on Terraces Along Streams

Dakota and Waukegan.—The Dakota, Waukegan, Meridian, Marshan, Plainfield, and Sparta soils make up this association, which covers only about 2 percent of the county. The Dakota are dark, loamy or sandy soils that formed on sandy outwash plains. The Waukegan are dark silty or loamy soils that formed on glacial outwash plains or stream terraces. The Marshan soil is very poorly drained. It has formed on silty stream terraces or outwash plains. The Plainfield and Sparta soils, mapped as undifferentiated units, are droughty. They have formed from wind-laid or water-laid sands and are on outwash plains. The Meridian soils are sandy and droughty. They were derived mainly from sandstone or limestone residuum, and they occupy stream terraces.

Few, if any, farms are entirely within this association. Except on the stronger slopes, the Dakota and Waukegan soils are well suited to row crops and small grains. The Marshan soil is also well suited to row crops and small grains if adequately drained. The Meridian, Plainfield, and Sparta soils are well suited to grass or trees. Under careful management they can be used for truck crops.

Soils on Bottom Lands

Alluvial land.—This association occupies about 8 percent of the county. It consists of Alluvial land, Mixed alluvial land, and undifferentiated units of Chaseburg and Judson soils. The alluvial lands occupy flood plains of larger streams. The Chaseburg and Judson soils occur in narrow areas along upper drainageways in the part of the county that is more dissected by streams. They also occupy alluvial-colluvial fans.

All of the alluvial lands are subject to overflow. Most of the soils in the association are medium textured and well drained to moderately well drained. They are well suited to row crops and small grains if protected from overflow. The coarse-textured or poorly drained alluvial lands and the deeper mixed alluvial lands are better suited to pasture or trees. Most areas

TABLE 2.—*Approximate acreage and proportionate extent of soils mapped in Fillmore County, Minn.*

Soil	Acres	Percent
Alluvial land, medium textured, poorly drained	1,737	0.3
Alluvial land, medium textured, well drained	8,713	1.6
Alluvial land, coarse textured, well drained	1,924	.3
Chaseburg and Judson silt loams, 0 to 1 percent slopes	5,909	1.1
Chaseburg and Judson silt loams, 2 to 6 percent slopes	11,304	2.1
Chelsea and Boone loamy fine sands, 2 to 6 percent slopes	309	.1
Chelsea and Boone loamy fine sands, slightly or moderately eroded, 7 to 11 percent slopes	537	.1
Chelsea and Boone loamy fine sands, 12 to 17 percent slopes	385	.1
Chelsea and Boone loamy fine sands, 18 to 35 percent slopes	1,205	.2
Clyde silty clay loam	3,744	.7
Clyde silty clay loam, overwash	4,128	.8
Dakota fine sandy loam, shallow, 0 to 1 percent slopes	336	.1
Dakota fine sandy loam, shallow, 2 to 6 percent slopes	1,194	.2
Dakota fine sandy loam, eroded, shallow, 2 to 6 percent slopes	1,351	.2
Dakota fine sandy loam, eroded, shallow, 12 to 17 percent slopes	50	.0
Dakota loam, 0 to 1 percent slopes	1,152	.2
Dakota loam, 2 to 6 percent slopes	2,016	.4
Dickinson fine sandy loam, 0 to 6 percent slopes	536	.1
Dickinson fine sandy loam, eroded, 2 to 6 percent slopes	624	.1
Dickinson fine sandy loam, eroded, 7 to 11 percent slopes	400	.1
Dickinson fine sandy loam, moderately deep, 2 to 6 percent slopes	444	.1
Dickinson fine sandy loam, moderately deep, eroded, 2 to 6 percent slopes	1,440	.3
Dickinson fine sandy loam, moderately deep, eroded, 7 to 11 percent slopes	300	.1
Dickinson loam, 2 to 6 percent slopes	300	.1
Dickinson loam, eroded, 2 to 6 percent slopes	150	.0
Dickinson loam, eroded, 7 to 11 percent slopes	244	.0
Dubuque and Whalan silt loams, shallow, 2 to 6 percent slopes	1,418	.3
Dubuque and Whalan silt loams, shallow, eroded, 2 to 6 percent slopes	1,924	.3
Dubuque and Whalan silt loams, shallow, eroded, 7 to 11 percent slopes	8,006	1.5
Dubuque and Whalan silt loams, shallow, slightly or moderately eroded, 12 to 17 percent slopes	10,092	1.8
Dubuque and Whalan silt loams, shallow, severely eroded, 12 to 17 percent slopes	246	.0
Dubuque and Whalan silt loams, shallow, 18 to 45 percent slopes	21,462	3.9
Escarpments	2,386	.4
Fayette silt loam, 0 to 1 percent slopes	410	.1
Fayette silt loam, 2 to 6 percent slopes	22,731	4.1
Fayette silt loam, eroded, 2 to 6 percent slopes	70,352	12.7
Fayette silt loam, eroded, 7 to 11 percent slopes	74,480	13.5
Fayette silt loam, severely eroded, 7 to 11 percent slopes	789	.1
Fayette silt loam, eroded, 12 to 17 percent slopes	27,804	5.0
Fayette silt loam, severely eroded, 12 to 17 percent slopes	921	.2
Fayette silt loam, slightly or moderately eroded, 18 to 45 percent slopes	8,025	1.5
Fayette silt loam, terrace, 2 to 6 percent slopes	600	0.1
Fayette silt loam, terrace, eroded, 2 to 6 percent slopes	490	.1
Fayette silt loam, terrace, eroded, 7 to 17 percent slopes	307	.1
Floyd and Clyde silty clay loams, overwash, 0 to 3 percent slopes	20,660	3.8
Hixton fine sandy loam, slightly or moderately eroded, 2 to 11 percent slopes	301	.1
Hixton fine sandy loam, slightly or moderately eroded, 12 to 35 percent slopes	569	.1
Kasson silt loam, 0 to 1 percent slopes	10,608	1.9
Kasson silt loam, 2 to 6 percent slopes	3,888	.7
Kato silty clay loam	327	.1
Kenyon silt loam, 0 to 1 percent slopes	1,192	.2
Kenyon silt loam, 2 to 6 percent slopes	8,832	1.6
Lindstrom silt loam and fine sandy loam, 2 to 6 percent slopes	273	.0
Lindstrom silt loam and fine sandy loam, 7 to 11 percent slopes	1,535	.3
Lindstrom silt loam and fine sandy loam, slightly or moderately eroded, 12 to 17 percent slopes	1,483	.3
Lindstrom silt loam and fine sandy loam, 18 to 45 percent slopes	2,943	.5
Marshan silty clay loam	250	.0
Meridian fine sandy loam, 0 to 1 percent slopes	250	.0
Meridian fine sandy loam, slightly or moderately eroded, 2 to 6 percent slopes	302	.1
Mixed alluvial land, 0 to 6 percent slopes	15,719	2.9
Mixed alluvial land, 7 to 17 percent slopes	369	.1
Plainfield and Sparta loamy fine sands, slightly or moderately eroded, 2 to 6 percent slopes	631	.1
Plainfield and Sparta loamy fine sands, eroded, 7 to 11 percent slopes	224	.0
Peat and muck	480	.1
Racine and Ostrander silt loams and loams, 0 to 1 percent slopes	4,992	.9
Racine and Ostrander silt loams and loams, 2 to 6 percent slopes	7,971	1.4
Racine and Ostrander silt loams and loams, eroded, 2 to 6 percent slopes	3,074	.6
Racine and Ostrander silt loams and loams, eroded, 7 to 11 percent slopes	565	.1
Racine and Ostrander silt loams and loams, eroded, 12 to 17 percent slopes	587	.1
Renova silt loam and loam, 0 to 1 percent slopes	590	.1
Renova silt loam and loam, 2 to 6 percent slopes	2,905	.5
Renova silt loam and loam, eroded, 2 to 6 percent slopes	5,830	1.1
Renova silt loam and loam, eroded, 7 to 11 percent slopes	3,902	.7
Renova silt loam and loam, eroded, 12 to 17 percent slopes	614	.1
Rockton and Dodgeville silt loams, shallow, 2 to 6 percent slopes	2,126	.4
Rockton and Dodgeville silt loams, shallow, eroded, 2 to 6 percent slopes	4,337	.8
Rockton and Dodgeville silt loams, shallow, eroded, 7 to 11 percent slopes	2,047	.4
Rockton and Dodgeville silt loams, shallow, eroded, 12 to 17 percent slopes	748	.1
Rockton and Dodgeville silt loams, shallow, 18 to 35 percent slopes	842	.2
Schapville silt loam and silty clay loam, 2 to 6 percent slopes	293	.1
Schapville silt loam and silty clay loam, 7 to 11 percent slopes	3,487	.6

TABLE 2.—*Approximate acreage and proportionate extent of soils mapped in Fillmore County, Minn.* (continued)

Soil	Acres	Percent
Schapville silt loam and silty clay loam, slightly or moderately eroded, 12 to 17 percent slopes	851	0.2
Seaton and Port Byron silt loams, eroded, 2 to 6 percent slopes	80	.0
Seaton and Port Byron silt loams, eroded, 7 to 11 percent slopes	150	.0
Seaton and Port Byron silt loams, eroded, 12 to 17 percent slopes	170	.0
Skyberg silt loam, 0 to 3 percent slopes	2,976	.5
Sogn silt loam, 0 to 6 percent slopes	170	.0
Sogn silt loam, eroded, 7 to 11 percent slopes	1,251	.2
Steep rocky land	39,110	7.1
Tama and Downs silt loams, 0 to 1 percent slopes	864	.2
Tama and Downs silt loams, 2 to 6 percent slopes	22,813	4.1
Tama and Downs silt loams, eroded, 2 to 6 percent slopes	32,118	5.8
Tama and Downs silt loams, 7 to 11 percent slopes	1,419	.3
Tama and Downs silt loams, eroded, 7 to 11 percent slopes	15,880	2.9
Tama and Downs silt loams, 12 to 17 percent slopes	879	.2
Tama and Downs silt loams, eroded, 12 to 17 percent slopes	2,024	.4
Tama and Downs silt loams, severely eroded, 12 to 17 percent slopes	265	.0
Tama and Downs silt loams, 18 to 35 percent slopes	1,656	.3
Thurston and Wykoff loams, moderately deep, 0 to 1 percent slopes	1,488	.3
Thurston and Wykoff loams, moderately deep, eroded, 2 to 6 percent slopes	1,617	.3
Thurston and Wykoff loams, moderately deep, eroded, 7 to 17 percent slopes	279	.1
Thurston and Wykoff sandy loams, shallow, 0 to 1 percent slopes	250	.0
Thurston and Wykoff sandy loams, shallow, eroded, 2 to 6 percent slopes	300	.1
Thurston and Wykoff sandy loams, shallow, eroded, 7 to 11 percent slopes	480	.1
Waukegan silt loam, 0 to 1 percent slopes	771	.1
Waukegan silt loam, 2 to 6 percent slopes	3,278	.6
Total	549,760	100.0

are so small that few, if any, farms are entirely within the association.

Shallow or Steep Soils

Steep rocky land and Escarpments.—This association occupies slightly less than 8 percent of the county. It consists mainly of Steep rocky land and Escarpments. A small acreage of Schapville and Sogn soils is included. Steep rocky land is a miscellaneous land type that lies chiefly below the upland loessal, glacial, or residual soils and above the colluvial or alluvial soils of the valleys.

Escarpments, also a miscellaneous land type, consists of mixed terrace and glacial materials on kames, rolling moraines, and terrace escarpments.

The Schapville soils are poorly drained to moderately well drained prairie soils derived from thin loess that lies over residuum derived from calcareous shales. The Sogn soils are very shallow, dark soils that formed on residuum derived from limestone and shale. The less sloping phases of the Schapville and Sogn soils are suited to row crops and small grains. The miscellaneous land types in the association are suited only to pasture or trees.

Soil Descriptions

In the following pages the soils, identified by the same symbols as those used on the soil map, are described, and their various suitabilities for agriculture are discussed. Their location and distribution are shown on the soil map, and their approximate acreage and proportionate extent are given in table 2. Their suitability for use, management requirements, and expected average yields are discussed in the section, Use, Management, and Productivity of the Soils.

Alluvial Lands

Alluvial land, medium textured, poorly drained (Aa) (IIIw–3).—This mapping unit is a mixture of dark-colored soils on the bottom lands. Because they are so mixed, the alluvial soils in this report are not separated into series, types, and phases.

The soils of this unit are not extensive. They occur on nearly level or slightly depressed areas and along stagnant channels of the flood plains. As a rule they lie next to larger areas of better drained soils. The surface layers of the wetter soils are generally thicker and darker than those that are better drained. Thickness and color vary greatly in these soils, but the surface soils are usually silty clay loams.

Periodic floods inundate the soils of this unit. The finer textured soils, which usually occupy low-lying positions, remain saturated for varying periods, and often a thin layer of muck covers them.

This mapping unit is moderately productive, but floods reduce crop yields. Although corn is the chief crop grown on the better drained areas, hay and pasture do well. Many areas are permanently wet, and on these the vegetation consists mainly of marsh-grasses and other water-tolerant plants. Except for limited grazing, the wettest areas are of little agricultural value.

Alluvial land, medium textured, well drained (Ab) (IIw–3).—In this mapping unit are well-drained soils of the bottom lands. They occur in almost every valley along the streams. The largest areas are located in the wide valleys of the Root River and its tributaries and along the Upper Iowa River.

All of the soils in this unit have silty surface layers. They vary, however, in color of the surface layer, depth to carbonates, and composition of the subsurface layer.

In places the surface soil is very dark grayish brown silty clay loam. Lenses of coarse sand or gravel occur in some places. In other places the surface soil is light colored and very silty, particularly in those areas where the sediments have washed principally from the light-colored Fayette soils.

Also common are areas where light-colored surface soil overlies dark-colored subsoil. This light-colored soil has probably washed from the adjacent slopes since they were cleared and farmed.

The wider areas in the valleys, which are flooded only occasionally, are cultivated fairly intensively. Corn is the major crop, and yields are generally as high as on the best upland soils. The uncultivated areas are used for grazing and often provide excellent pasture.

Alluvial land, coarse textured, well drained (Ac) (IIIw–3).—This mapping unit is a mixture of sandy alluvial materials that were deposited by streams during floods. The few scattered, mostly small areas occur on bottom lands, usually adjacent to streams. The areas are sometimes flooded in spring and at other times of heavy rainfall. They are generally used for crops and pasture.

Chaseburg and Judson Soils

Chaseburg and Judson silt loams occupy long narrow strips in valley fills and along the upper reaches of drainageways in the dissected part of the county. They are so closely associated that it was not practicable to show them separately on the map. They are nearly level to sloping, deep, well-drained, silty soils that differ primarily in color of their surface layer. Surface and internal drainage are good.

General profile for Judson silt loam:

0 to 20 inches, very dark brown to black friable silt loam.
20 to 30 inches, dark-gray to dark grayish-brown friable silt loam.
30 to 48 inches, brown, grading to yellowish brown, friable silt loam.

Chaseburg silt loams have a lighter colored surface layer than the Judson silt loams, are more uniformly brown throughout, and do not have the grayish transitional layer shown at depths of 20 to 30 inches in the profile for Judson silt loam.

Chaseburg and Judson silt loams, 0 to 1 percent slopes (Ca) (IIw–1).—These well-drained young soils occur in all parts of the county—in shallow depressions of the uplands, in wide flat drainageways, and along low foot slopes. They have formed from colluvium and alluvium that washed from higher lying soils derived from loess and glacial till. The lighter colored Chaseburg silt loam is more extensive than the dark-colored Judson silt loam. The soil materials washed mainly from Fayette and other light-colored soils.

Runoff is generally slow on these nearly level soils, and erosion is no problem. Internal drainage is medium. The capacity to absorb and hold moisture is medium to high. Tilth is fair to good.

The soil materials have accumulated so recently that the soils have no true native vegetation. The soils are productive, especially where the materials came from fertile soils. They are well suited to corn, soybeans, and hay.

Chaseburg and Judson silt loams, 2 to 6 percent slopes (Cb) (IIw–1).—These soils occur along the upper reaches of drainageways and on foot slopes of the glacial and loessal uplands. They have a profile similar to that of Chaseburg and Judson silt loams, 0 to 1 percent slopes, but the accumulation of colluvial and alluvial materials is not so thick. New materials periodically deposited by streams keep these soils productive. They are well drained, moderately permeable, and moderate in their capacity to absorb and hold moisture. Runoff is medium.

Some areas, especially those that are small and narrow, are managed with the surrounding soils. Most of the larger areas are farmed as separate units. Little or no fertilizer is used on corn, soybeans, and hay. Average yields are fairly high.

Chelsea and Boone Soils

The Chelsea and Boone soils have formed on sandstone or sandy colluvial material on slopes ranging from 2 to 35 percent. They occur most commonly in narrow strips or in small areas above or below outcrops of St. Peter or Jordan sandstone, and in valley fills. They are mostly in the eastern part of the county. The two soils are not separated on the map because they usually occur together and need about the same management. These light-colored sandy soils are conspicuous in the landscape.

Profile description (Boone loamy fine sand):

0 to 3 inches, dark grayish-brown loose loamy fine sand.
3 to 10 inches, grayish-brown very loose fine sand.
10 to 30 inches, yellowish-brown structureless fine sand.
30 to 80 inches +, light yellowish-brown loose fine sand; sandstone fragments common; gradual transition to sandstone bedrock, which is at depths of 2 to 10 feet.

Boone loamy fine sand contains exceptionally large amounts of quartz and few other minerals.

On colluvial slopes the Boone soil, and the Chelsea as well, are 10 to 30 feet or more deep to bedrock.

The profile of Chelsea loamy fine sand is very similar to that of the Boone. It is slightly finer textured because it contains a mixture of silt and other fine particles. It further differs in having thin, dark-brown, stratified layers at depths of 4 to 6 feet. In many respects the Chelsea soils resemble the Plainfield soils.

Chelsea and Boone soils are excessively drained. Their moisture-holding capacity and supply of plant nutrients are very low. Water erosion is slight, but wind erosion is a hazard on unprotected slopes. The Chelsea and Boone soils are not well suited to crops. Use and management are the same for both soils.

Chelsea and Boone loamy fine sands, 2 to 6 percent slopes (Cc) (IVs–2).—These soils occur on gently sloping to sloping areas where sandstone bedrock outcrops. They are uneroded to slightly eroded. Low fertility, low moisture-holding capacity, and risk of erosion limit their use for crops. Conservation practices that will increase the moisture supply and prevent erosion are needed. Row crops should not be grown more than 2 years in a 5-year rotation. Hay or other cover crops should make up the rest of the rotation.

Areas not suitable for cultivation should be used for permanent pasture or forest.

Chelsea and Boone loamy fine sands, slightly or moderately eroded, 7 to 11 percent slopes (Cd) (IVs–3).—Many areas of these soils are in pasture and forest. Where they are cultivated, erosion has resulted. In some places erosion has removed 25 to 75 percent of the surface soil. Pasture and forest are the best uses for the soils. If they are cropped, good management practices are needed to control erosion and conserve water.

Chelsea and Boone loamy fine sands, 12 to 17 percent slopes (Ce) (VIIs–1).—Little of the surface soil has been lost through erosion because practically all the areas of these soils are forested. These soils are droughty, sandy, and subject to severe wind and water erosion, if cleared. To prevent further erosion losses, they should be kept in trees.

Chelsea and Boone loamy fine sands, 18 to 35 percent slopes (Cf) (VIIs–1).—Except for the steeper slopes, these soils are similar to the other phases of Chelsea and Boone soils. They occur on steep wooded slopes or on cleared hillsides in the more dissected areas of the county. On some of the areas, erosion has removed between 25 and 75 percent of the surface soil, particularly on the breaks of ridges. These soils are not extensive, although small individual areas are numerous.

Many areas have been cleared and are used for pasture. They are, however, better suited to forest because of the erosion hazard. Droughtiness, steep slopes, and erosion limit the use of these soils for other than trees or light grazing.

Clyde Soils

The dark-colored Clyde soils occur in very poorly drained depressional areas on the glacial till plain. They are associated with Floyd, Kenyon, and Ostrander soils, which occupy adjacent higher lying areas on the glacial uplands. Clyde soils have formed from Iowan glacial till under a cover of swampgrass. The black color and organic-matter content of these soils have resulted from the decay of sedges and rank sloughgrass. In places a thin layer of muck covers the surface. The most extensive areas of these soils are in Beaver, York, and Sumner Townships.

Profile description (Clyde silty clay loam):

0 to 12 inches, black silty clay loam; fine granular structure; plastic.
12 to 18 inches, very dark gray, medium granular, silty clay loam; very plastic when wet.
18 to 25 inches, olive-gray silty clay loam, mottled with dark brown; a gley horizon.
25 inches +, a light olive-brown glacial till; sandy clay texture.

Because of their low position, the Clyde soils are periodically flooded, especially after heavy rains. Except during dry periods, the water table is often very high and the soils are excessively moist. A few areas are saturated most of the time. Artificial drainage is needed for successful crop production.

Clyde silty clay loam (Cg) (IIIw–1).—This soil, to depths of about 12 to 20 inches, is very dark gray plastic silty clay loam, high in organic matter. This layer is underlain by a dark grayish-brown or olive-gray very plastic silty clay that has rust-brown and yellow mottlings. Sand and gravel occur in varying amounts in the lower layers. The quantity increases with depth. In some places many boulders are on the surface.

Undrained areas of this soil are used for pasture. Drained areas are cropped to corn, hay, and small grains. Excellent yields of corn are often obtained, even in dry years, on adequately drained areas.

This soil is fertile, but because of its heavy texture and wetness, it is often difficult to work. It is generally too moist to plow early in spring. Plowing ordinarily should be done in fall, so that freezing and thawing can break up the clods.

Clyde silty clay loam, overwash (Ch) (IIIw–1).—This soil has a thicker surface layer than Clyde silty clay loam. Also, it occurs in slightly deeper depressions or in areas that receive runoff from the adjacent higher lying uplands. It is downslope from the associated Floyd and Kenyon soils. Drainage is very poor, and as for all Clyde soils, artificial drainage is needed before this soil can be cultivated. Use and management for Clyde silty clay loam also apply to this soil.

Dakota Soils

The Dakota soils are dark-colored level to undulating prairie soils on glacial outwash plains. Their slopes range from 0 to 17 percent. The soils have developed on sandy and gravelly material under prairie grasses.

Profile description (Dakota loam):

0 to 10 inches, very dark brown friable loam.
10 to 15 inches, dark-brown slightly plastic heavy loam.
15 to 30 inches, dark yellowish-brown heavy loam; moderately developed blocky structure.
30 inches +, yellowish-brown, medium to coarse, acid sand and fine gravel; stratified.

Profile description (Dakota fine sandy loam):

0 to 6 inches, very dark grayish brown friable fine sandy loam; structureless.
6 to 15 inches, dark yellowish-brown friable heavy sandy loam to loam.
15 to 20 inches, yellowish-brown gravelly sandy loam; slightly plastic when wet.
20 inches +, light yellowish-brown, acid, fine to coarse, stratified sand and gravel.

As shown in the foregoing profiles, the Dakota loams have finer textured surface soils and subsoils than the Dakota fine sandy loams and are not so deep to the sand-and-gravel substratum. The loams are well drained, and the sandy loams are somewhat excessively drained.

Most of the areas are cropped to corn, soybeans, small grains, and hay. Lack of moisture late in summer often injures crops, particularly on the Dakota fine sandy loams. During dry periods, wind may slightly erode these soils.

Dakota fine sandy loam, shallow, 0 to 1 percent slopes (Da) (IIIs–1).—This soil lies on glacial terraces above overflow. Depth of the soil to the coarse substratum varies from 20 to 36 inches. Runoff and internal drainage are rapid. The soil formed under prairie grasses and a sparse forest growth, mainly scrub oak. Crop yields are low if rainfall is below normal. A few areas are in wooded pasture.

Dakota fine sandy loam, shallow, 2 to 6 percent slopes (Db) (IIIs–1).—This soil occupies gently sloping to sloping areas, chiefly along the larger streams in the southwestern part of the county. Depth to sand and gravel varies from 20 to 36 inches. Runoff and internal drainage are rapid. Little erosion is apparent, but the soil will erode readily under poor management.

Dakota fine sandy loam, eroded, shallow, 2 to 6 percent slopes (Dc) (IIIs–1).—This soil occurs on undulating slightly dissected outwash plains, usually where minor tributary drainageways have cut the terraces, or where colluvial deposits have accumulated below uplands. Droughtiness may be a more serious problem on this soil than on the nearly level areas, and erosion may be more severe.

Dakota fine sandy loam, eroded, shallow, 12 to 17 percent slopes (Dd) (VIIs–1).—Except for erosion and steepness of slope, this soil resembles Dakota fine sandy loam, shallow, 2 to 6 percent slopes. This steeper phase is so susceptible to erosion that it should not be used for row crops. It is best suited to trees or pasture.

Dakota loam, 0 to 1 percent slopes (De) (IIe–3).—This soil resembles the Dakota fine sandy loams but has a deeper solum and a finer textured surface soil. It occupies areas on the glacial outwash plain, particularly in the Upper Iowa River valley along the Iowa State line.

The surface soil is very dark brown and fairly high in organic matter. At depths of 30 to 42 inches are stratified layers of loose porous sand and gravel of varying thickness.

Runoff is medium, and internal drainage is medium to rapid. Except during long dry periods, there is enough moisture for most crops. The soil is easy to work and can be plowed throughout a wide range of moisture content.

Dakota loam, 2 to 6 percent slopes (Df) (IIe–3).—This soil occurs on more dissected areas than Dakota loam, 0 to 1 percent slopes, but is otherwise similar.

Dickinson Soils

The Dickinson soils are moderately dark to dark colored and are well drained to somewhat excessively drained. They occur chiefly on gently sloping to sloping areas, but the range is normally from level to rolling. They occur on knolls and low morainic ridges in the glacial uplands, where they are associated with Ostrander and Kenyon soils and, in places, with Thurston soils. They are mainly in Sumner, York, and Bloomfield Townships. Several long, narrow, fairly continuous, low ridges occupied by these soils are conspicuous on the glaciated plain.

The Dickinson soils differ from other glacial till soils in having a loose sandy substratum at depths ranging from 30 to 42 inches. Texture, thickness, and color of the surface layers vary considerably. The texture ranges from loamy fine sand to loam; thickness ranges from 4 to 16 inches; and color from slightly dark to very dark.

These soils are easily worked. Except in dry periods when winds erode, erosion is seldom a problem. Permeability is moderate to rapid, and the moisture-holding capacity is low. Little water runs off because the soils are porous. The soils are normally droughty, so yields are substantially lowered in long dry periods.

The main crops grown on the Dickinson soils are corn, soybeans, small grains, and hay. Yields generally average somewhat lower on these soils than on the finer textured soils of the glacial uplands.

Profile description (Dickinson fine sandy loam):

0 to 15 inches, very dark grayish brown friable fine sandy loam.
15 to 30 inches, dark yellowish-brown heavy very fine sandy loam; coherent.
30 inches +, yellowish-brown loose fine sand.

Dickinson fine sandy loam, 0 to 6 percent slopes (Dg) (IIIs–1).—This level to sloping soil has developed from sandy Iowan drift. It normally has a thicker surface layer than the more rolling Dickinson fine sandy loams. It is more droughty than the moderately deep phases of Dickinson fine sandy loam, but it is less droughty than the more rolling Dickinson fine sandy loams. Crop yields are normally somewhat lower than for Dickinson loam, 2 to 6 percent slopes.

Dickinson fine sandy loam, eroded, 2 to 6 percent slopes (Dh) (IIIs–1).—From 25 to 75 percent of the surface layer has been removed from this soil through erosion. Erosion is more severe than on Dickinson fine sandy loam, 0 to 6 percent slopes, and it should be controlled to prevent further losses.

Dickinson fine sandy loam, eroded, 7 to 11 percent slopes (Dk) (IVs–1).—Erosion has removed the organic matter from this soil, and the soil is now poor for cultivation. Between 25 and 75 percent of the surface soil has been lost. The soil is also extremely droughty and has a very low supply of plant nutrients. To help prevent further erosion, this soil should be used for pasture or forest.

Dickinson fine sandy loam, moderately deep, 2 to 6 percent slopes (Dl) (IIIs–1).—This soil has developed from sandy Iowan drift. Its upper layers are similar to those described in the profile of Dickinson fine sandy loam. The subsoil, occurring at depths of 30 to 42 inches, is medium-textured glacial till or a fine material. In some places the medium-textured glacial till has no stratified coarse layers below it. In others the stratified layers are composed of alternately coarse and fine materials. This soil is not so extensive as the shallower Dickinson fine sandy loams. A few large areas occur in York Township.

The sandy and porous surface soil is easy to work. The soil is permeable and is well drained to somewhat excessively drained. The moisture-holding capacity is moderate to low. It is, however, slightly higher than in the associated Dickinson soils because the soil has medium-textured layers. Except in years of above normal rainfall, this soil is frequently droughty.

Dickinson fine sandy loam, moderately deep, eroded, 2 to 6 percent slopes (Dm) (IIIs–1).—This soil is the most extensive of the Dickinson fine sandy loams, although the total acreage is small. Erosion has removed from 25 to 75 percent of the surface soil. The chief management practices needed on this soil are those that will prevent further erosion, increase the supply of plant nutrients and organic matter, and improve the moisture-supplying capacity.

Dickinson fine sandy loam, moderately deep, eroded, 7 to 11 percent slopes (Dn) (IVs–1).—Erosion caused by improper management has removed up to 75 percent of the surface layer of this soil. Unless it is carefully managed, the soil should not be planted to row crops. It is better used for pasture or forest.

Dickinson loam, 2 to 6 percent slopes (Do) (IIe–3).—This is the most extensive of the Dickinson loams; it occurs on the flat tops of the sandy morainic ridges. It is associated with other Dickinson soils, which have developed from sandy glacial drift of the Iowan glaciation. It is also associated with Racine and Ostrander silt loams and Kenyon silt loams. It has a thicker and darker colored surface layer than any of the other Dickinson soils and is finer textured throughout the solum. The subsoil is slightly more coherent than in the Dickinson fine sandy loams, and the profile is more developed.

Dickinson loam, 2 to 6 percent slopes, is easily worked. The organic-matter content is high. The soil is well drained and permeable, and the moisture-holding capacity is moderate. During long dry periods, the soil is somewhat droughty. Erosion is not severe. In general this is the best of the Dickinson soils for agriculture.

Crops grown on this soil include corn, soybeans, small grains, and hay. Yields average slightly lower than on the Kenyon and Racine and Ostrander soils, but they are higher than on most sandy soils. Good management practices should include a program to conserve water, to keep up the organic-matter content, and to control wind erosion.

Dickinson loam, eroded, 2 to 6 percent slopes (Dp) (IIe–3).—This soil resembles Dickinson loam, 2 to 6 percent slopes, but it has lost much of its surface soil, is not so well suited to crops, and normally yields less. The soil needs practices that will control water and wind erosion, maintain organic matter, and improve the moisture-holding capacity. It responds well to all improvements.

Dickinson loam, eroded, 7 to 11 percent slopes (Dr) (IVe–1).—Measures to control water and wind erosion are needed on this soil, particularly where it is cropped. Short rotations, stripcropping, and contour plowing help to control erosion.

Dubuque and Whalan Soils

The Dubuque and Whalan silt loams are light-colored shallow soils. They were not separated in mapping because they have many characteristics in common and need about the same kind of management. They formed under forest and are associated with Sogn, Fayette, and Renova soils. The chief difference among the soils is in the parent material.

The shallow phases of the Dubuque silt loams are associated with the Fayette soils. They have developed from loess and underlying residuum that weathered from limestone bedrock. The smaller areas are located in cultivated fields that are occupied mainly by Fayette soils. Limestone fragments are commonly scattered over the surface of these fields.

When cultivated, Dubuque soils have moderate to severe sheet erosion and a few gullies. In cutover or wooded areas, sheet erosion is slight but there are a few gullies.

The shallow phases of the Whalan silt loams are associated with the Renova soils. They have developed from thin deposits of glacial till that overlie limestone bedrock.

Profile description of Dubuque silt loam:

0 to 3 inches, very dark grayish brown silt loam; weakly granular.
3 to 12 inches, dark grayish-brown friable silt loam; platy structure.
12 to 20 inches, dark-brown heavy silt loam; blocky structure.
20 to 30 inches, reddish-brown gritty silty clay loam; limestone residuum.
30 inches +, limestone bedrock.

Whalan silt loam has a profile similar to that of Dubuque silt loam.

The Dubuque and Whalan soils are moderately well drained to well drained. Runoff is medium to rapid, and the soils are highly erodible. The moisture-supplying capacity is fairly low, and in dry periods these soils are often droughty and produce somewhat lower yields than the associated deeper soils.

Most areas are used for permanent pasture and forest, but some are cropped to corn, small grains, and hay. Where cropped, these soils generally occupy only a small part of a larger area occupied by the deeper Renova or Fayette soils.

Dubuque and Whalan silt loams, shallow, 2 to 6 percent slopes (Ds) (IIIe–2).—These soils occur on gently sloping to sloping areas of both the loessal and glacial uplands. They are ordinarily in pasture or forest. Little erosion has occurred. The soils are, however, very erodible if cropped; erosion control is the chief management problem. Droughtiness is common. Most cleared areas are used for hay and pasture, but some are cropped to corn, small grains, and soybeans.

Dubuque and Whalan silt loams, shallow, eroded, 2 to 6 percent slopes (Dt) (IIIe–2).—Except for erosion, these soils resemble other Dubuque and Whalan soils. Between 25 and 50 percent of the surface soil has been removed. Only a thin layer remains. Too much cropping to corn has probably caused the erosion. Contour tillage, stripcropping, and use of long crop rotations in combination with proper fertilization are practices suitable for controlling erosion. Lime is generally needed to establish legume seedings.

Dubuque and Whalan silt loams, shallow, eroded, 7 to 11 percent slopes (Du) (IVe–2).—These soils occur on the dissected uplands, usually adjacent to streams, where the degree of erosion indicates too much cropping to corn or other clean-cultivated crops. Much of the surface soil has been removed. If further losses from erosion are to be prevented, these soils should be pastured or used in long rotations that include a high proportion of legumes. In addition to stripcropping or contour tillage on these soils, grassed waterways should be used.

The soils are best suited to pasture and hay, but if proper erosion control is practiced, they can be cropped to corn and small grains. Yields are somewhat lower than on the deeper adjacent soils.

Dubuque and Whalan silt loams, shallow, slightly or moderately eroded, 12 to 17 percent slopes (Dv) (VIe–1).—These soils are associated with other Dubuque and Whalan soils, with Sogn or Fayette soils, and with Steep rocky land. They occur on the dissected uplands and on moderately steep valley slopes. They should not be used for row crops, because of their severe erodibility. Areas now under cultivation should be converted to pasture. Pasture and forest are the best uses for these soils. Considerable soil renovation is necessary to establish adequate permanent pasture.

Dubuque and Whalan silt loams, shallow, severely eroded, 12 to 17 percent slopes (Dw) (VIIe–1).—On these soils severe erosion has removed most of the surface soil. The subsoil is exposed in many places; gullies and outcrops are common. The soils occur on highly dissected uplands where runoff is rapid and soil losses are severe. Erosion control is extremely difficult. In places it is probably not worthwhile to try to improve the soils for hay or pasture. Most areas are best suited to permanent pasture or forest.

Dubuque and Whalan silt loams, shallow, 18 to 45 percent slopes (Dx) (VIIe–1).—These soils are common on the steep slopes of the strongly dissected uplands. Erosion, under past management, has removed much of the surface soil. It is difficult to prevent, even on pasture. These soils are not suited to crops and because of their shallowness and erodibility, they should be in permanent pasture or forest. Pasture management should include choice of suitable seed mixtures, control of grazing, and eradication of weeds. Lime should be applied before a pasture is seeded. Areas that are poor for pasture should be left to revert to forest. Many areas will revert naturally, but planting may be necessary in others.

Escarpments

Escarpments (Ea) (VIIs–1).—This land type is on 17 to 35 percent slopes. It is classified as a Regosol, and it has developed from extremely sandy or gravelly material. The areas are mainly on gravelly moraines of the glacial uplands and on terrace escarpments in the valleys. They are small and are scattered throughout the glacial drift plain and on high terraces and eroded benches along the large stream valleys.

The parent material is mixed glacial material and terrace material consisting of sand, gravel, and stones. Little profile development has taken place. The soil material is acid throughout. Erosion varies from none to severe. Drainage is excessive, and permeability is rapid. Internal drainage is rapid, and runoff is medium to rapid.

This land type is difficult to work because of the steep slopes and the coarse gravel and stones on the surface. Most areas are forested; those cleared are used for pasture. Pastures have a very low carrying capacity, and only light grazing should be permitted. The soil is too droughty and too steep for row crops.

Fayette Soils

The Fayette soils—all silt loams—are the most extensive soils in the county, and they are predominant in the eastern part. They have developed under a mixed hardwood forest from deposits of Peorian loess. They contain little organic matter, except in the surface layer. In this they differ from the dark colored and moderately dark colored Tama and Downs soils, with which they are normally associated. The natural vegetation was chiefly white, post, and bur oaks, and maples, elms, and other hardwoods.

Profile description in a virgin area (Fayette silt loam):

0 to 4 inches, very dark grayish-brown friable silt loam; platy structure.
4 to 12 inches, dark grayish-brown friable silt loam; well-developed platy structure.
12 to 20 inches, brown heavy silt loam; fine blocky structure.
20 to 45 inches, dark-brown, light silty clay loam; medium to coarse well-developed blocky structure; plastic when wet.
45 inches +, yellowish-brown friable silt loam (loess).

The aggregates in the subsoil are streaked and coated with light grayish-brown fine material.

Where these soils adjoin the Renova silt loams and loams, the subsoil at depths of 2 or 3 feet contains drift material. Where they adjoin the Tama and Downs silt loams and relief is less rolling, the surface soil is slightly darker. In some places limestone bedrock underlies the Fayette soils at depths of 24 to 48 inches. The bedrock is most frequently at these depths where the Fayette soils are transitional to shallow phases of Dubuque silt loams.

The soils are acid throughout. Because their surface layer is silty and contains no stones or gravel, they are easy to cultivate. Internal drainage and permeability are medium. Runoff is medium to rapid, depending on the slope. The soils are erodible, partly because of runoff and partly because of the loose loessal material. Cultivated fields have lost much of their original surface soil. Sheet erosion is moderate, and there are a few gullies. The steeper slopes commonly are severely sheet eroded and have many gullies.

The Fayette soils are extensively cultivated and are moderately productive. They yield a little less than the Tama and Downs or the Racine and Ostrander soils. Areas damaged by moderate or severe erosion are at least a third less productive than those not eroded. The soils are suitable for the crops generally grown in the county, and they respond well if properly managed. Most crops yield satisfactorily if commercial fertilizer and large amounts of barnyard or green manure are applied.

Fayette silt loam, 0 to 1 percent slopes (Fa) (I–1).—This light-colored soil occurs on smooth areas of the broad divides in the loess-covered uplands.

The soil is very friable and easy to work. Erosion is not a problem. Keeping or improving the fertility is important. Applying manure, lime, and commercial fertilizers heavily and rotating suitable crops will keep this soil productive. Good crops of corn, hay, and soybeans can be grown in well-managed areas.

Fayette silt loam, 2 to 6 percent slopes (Fb) (IIe–2).—Most areas of this soil occur near other light-colored soils on the crests of ridges in the hilly and dissected parts of the county. Large areas are common only on the broad divides, except in the southeastern part of the county. These large areas gradually merge with the Tama and Downs soils.

This soil is friable, loose, and easy to work. Practically all areas are cultivated. Without preventive practices, this soil will erode readily. Because of lower fertility, keeping this soil productive requires more care than is needed for the Tama and Downs soils. To keep good tilth and fertility, manure and commercial fertilizers should be applied and long rotations used. Contour tillage and stripcropping should be practiced on the stronger slopes.

Fayette silt loam, eroded, 2 to 6 percent slopes (Fc) (IIe–2).—This widely distributed soil is one of the most extensive of the Fayette silt loams. The surface soil and subsoil are slightly less silty than those of the associated uneroded phases. Erosion brought about by poor land use has caused some loss of surface soil. Tilth is poor in the severely eroded spots and in the scattered gullies. In places the soil layers are somewhat thinner than they were in the virgin state. Many areas of this soil occur on fairly shallow deposits of loess that overlies limestone bedrock. Sinkholes are numerous, especially near Harmony in Harmony Township and Wykoff in Fillmore and Fountain Townships. Where the soil is shallow, it gradually blends with the shallow phases of the Dubuque and Whalan silt loams.

Nearly all of this soil is cultivated, although there are some pastures and woodlots. Good yields of general farm crops can be obtained under proper management.

Considerable care is needed to prevent further erosion, to improve tilth, and to improve or maintain fertility. Contour tilling, terracing, stripcropping, or a combination of these, are good erosion control practices. Red clover and alfalfa loosen the soil, add nitrogen, and help control erosion. Lime should be applied before seeding legumes.

Fayette silt loam, eroded, 7 to 11 percent slopes (Fd) (IIIe–1).—This soil occurs in the dissected loessal uplands in association with Dubuque and Whalan silt loams, Sogn silt loams, and other phases of Fayette silt loam. Through improper management, part of the surface layer of this soil has been removed by erosion. The soil is less productive than the uneroded Fayette silt loams. It has poor tilth and is low in content of organic matter and plant nutrients.

Because of the risk of erosion, corn should not be grown on this soil except in a long rotation that includes a high proportion of legumes. The stronger slopes are best suited to hay and pasture. Control of erosion and improvement of fertility are the chief problems in management.

Fayette silt loam, severely eroded, 7 to 11 percent slopes (Fe) (IVe–1).—Areas of this soil normally are in the steep dissected sections, particularly adjacent to the streams and small V-shaped upper drainageways. Most of the surface soil has been removed through erosion. The profile layers are somewhat thinner than those of Fayette silt loams on gentler slopes.

Management problems are chiefly those of controlling erosion and improving the fertility. When stripcropped or terraced, this soil is suitable for forage crops and an occasional crop of corn or small grain.

Fayette silt loam, eroded, 12 to 17 percent slopes (Ff) (IVe–1).—This soil is not extensive. It generally occupies the more dissected areas, either near the upland escarpments or along the valley slopes of the larger streams. It commonly occurs next to shallower soils, such as the Dubuque and Whalan, Sogn, and Steep rocky land. Moderate erosion has removed part of the surface soil and, in places, has exposed the subsoil. Poor soil use has permitted the erosion.

Because of erodibility and strong slopes, this soil is not suited to crops that require cultivation. It has poor tilth and a low content of plant nutrients. Permanent pasture and forest are probably the most practical uses. Prevention of further erosion is the principal management problem. A good pasture management program should include improvement of old pastures through the use of fertilizer and proper seeding, controlled grazing, and clipping of weeds.

Fayette silt loam, severely eroded, 12 to 17 percent slopes (Fg) (VIe–1).—Severe erosion and strong slopes make this soil different from other phases of Fayette silt loam. Runoff has removed the surface soil and part of the subsoil.

Cultivated crops should not be grown on this soil. Permanent pastures should be kept on the improved areas, and forest on others. The chief management need is the prevention of further erosion.

Fayette silt loam, slightly or moderately eroded, 18 to 45 percent slopes (Fh) (VIIe–1).—Except for thinner surface and subsoil layers, this steep phase is similar to phases of Fayette silt loam on gentler slopes. It occurs on the loessal uplands and on valley walls and slopes in association with other phases of Fayette silt loam and with Dubuque and Whalan silt loams and Sogn silt loams. Winding gullies occur in some places. On areas that have been cropped, sheet erosion is severe.

Many areas of this soil are no longer cropped and are used principally for permanent pasture or as woodlots. This soil is suitable only for pasture and forest. Careful management is needed to produce profitable pasture and timber.

Fayette silt loam, terrace, 2 to 6 percent slopes (Fk) (IIe–2).—This is the most extensive of the Fayette silt loams that are on terraces. It is on high terraces adjacent to the major streams, especially along the Root River and its tributaries in the eastern part of the county. These terraces are high above overflow. The parent material was derived chiefly from light-colored loessal soils of the uplands—the Fayette silt loams already described, and the Dubuque and Whalan silt loams. The native vegetation consisted of mixed hardwoods, mainly elm, red oak, and walnut, with some aspen.

This soil, like the other terrace phases of Fayette silt loam, differs from the upland Fayette silt loams in having a sandy substratum, which is normally at depths of 48 to 60 inches.

The soil is easy to work and conserve and is moderately fertile. Surface drainage is medium, and internal drainage is medium to rapid. Permeability is moderate, and the moisture-holding capacity is moderate to low. Erosion is a problem on the stronger slopes, and the shallower areas tend to be droughty.

Corn and oats are the principal crops. Some hay is grown, and a small area is in pasture.

Fayette silt loam, terrace, eroded, 2 to 6 percent slopes (Fl) (IIe–2).—Erosion has been more active on this soil than on the other terrace phases of Fayette silt loam, and much of the surface soil has been lost. The stronger slopes are very susceptible to erosion, and measures should be taken to keep soil losses to a minimum.

Fayette silt loam, terrace, eroded, 7 to 17 percent slopes (Fm) (IIIe–1).—This soil is not extensive, and it generally occurs on fairly narrow areas adjacent to terrace escarpments. It is associated with other terrace phases of Fayette silt loam and with other soils on terraces. The soil is loose, and erosion has been moderate. Crops should be rotated and other erosion-control practices used to reduce soil losses.

Floyd and Clyde Soils

Floyd and Clyde silty clay loams, overwash, 0 to 3 percent slopes (Fn) (IIw–2).—These are dark-colored poorly and imperfectly drained soils that developed from glacial till. They occupy nearly level to gently sloping and slightly depressed areas on the glacial upland in the western part of the county. Associated with them are the better drained prairie soils (Kenyon silt loams and Racine and Ostrander silt loams and loams). The native vegetation consisted of tall prairie grasses, chiefly bluestem, and some sedges and water grasses.

Profile description (Floyd silty clay loam):

0 to 16 inches, black, plastic silty clay loam; fine granular structure.
16 to 25 inches, grayish-brown clay loam mottled with yellowish brown; medium to coarse blocky structure.
25 to 40 inches, olive-brown clay loam mottled with light gray and brown; coarse blocky structure.
40 inches +, light olive-brown clay loam (calcareous glacial till); massive.

Although natural drainage is poor to imperfect, drainage in most areas has been improved by ditches and tiles. Internal drainage and permeability are slow. The water table is frequently high. Generally it is highest in spring, which often delays seeding. The moisture-holding capacity of the soils is high, and crops always have enough moisture.

These soils are fertile. In those areas where natural or artificial drainage is adequate, they are among the best in the county for corn, soybeans, and small grains. Timothy and pasture grasses also do well. Artificial drainage is needed on the wetter areas for the successful growth of most crops.

The profile for the Clyde soil in this mapping unit is like that described for Clyde silty clay loam.

Hixton Soils

The Hixton soils are well drained. They occur principally in the more dissected areas in the eastern half of the county. They are on valley slopes and on talus slopes below the uplands. These soils are gently sloping to steep; slopes range from 2 to 35 percent. The soils have developed from mixed parent material derived from loess and from residuum weathered from fine-grained sandstones and shales. The native vegetation was mixed hardwoods, but now only a few woodlots remain.

The Hixton soils are associated with Lindstrom, Chelsea and Boone, and Dubuque and Whalan soils, and the terrace phases of the Fayette soils. The solum of the Hixton soils is coarser than that of the Fayette soils, and the subsoil is finer textured than that of the Chelsea and Boone soils.

Profile description (Hixton fine sandy loam):

0 to 3 inches, dark grayish-brown friable fine sandy loam.
3 to 9 inches, grayish-brown friable loamy fine sand to fine sandy loam.
9 to 30 inches, brown, heavy fine sandy loam.
30 to 55 inches, dark-brown fine sandy loam.
55 inches +, dark yellowish-brown loamy fine sand that becomes coarser with depth.

The surface soil ranges from loamy fine sand to loam, and the subsoil, from fine sandy loam to sandy clay loam or clay loam.

The internal drainage of these soils is medium to rapid, permeability is moderate to rapid, and the moisture-holding capacity is moderate to low. The soils are moderately low in plant nutrients. They are easy to work and moderately easy to conserve. They are largely cropped to oats, hay, and corn.

Hixton fine sandy loam, slightly or moderately eroded, 2 to 11 percent slopes (Ha) (IVs–1).—This inextensive soil generally occupies long narrow areas extending horizontally along the bottom of the talus slopes. The slopes and loose nature of the soil make it erodible. Areas that are timbered are only slightly eroded. Other areas, which have been in crops or pasture, have deep gullies.

On this soil it is necessary to control erosion and increase the moisture-holding capacity.

Hixton fine sandy loam, slightly or moderately eroded, 12 to 35 percent slopes (Hb) (VIIs–1).—Areas of this soil are generally on talus slopes adjacent to Steep rocky land or near the Dubuque and Whalan silt loams. The soil contains more coarse-textured material than Hixton fine sandy loam, slightly or moderately eroded, 2 to 11 percent.

On the steeper slopes runoff is very rapid, and on unprotected areas erosion is severe. Gullying is common in places, because of the steep slopes and loose, coarse-textured solum. The soil is best suited to trees and pasture.

Kasson Soils

The moderately well drained Kasson soils occur on nearly level to gently sloping areas. Long gentle slopes are typical of the Iowan glaciation in this region. Although they are almost entirely in the westernmost townships, they are widely distributed. These soils have developed from somewhat plastic till of the Iowan glaciation and are within the soil zone transitional between prairie and timber. They are generally associated with Skyberg silt loam, 0 to 3 percent slopes, but many areas are adjacent to the prairie soils (Kenyon and Racine and Ostrander). Like the Kenyon soils, the Kasson soils are better drained than the Skyberg soil. The Kasson soils are more strongly developed than the Kenyon soils and have thinner surface layers.

Undoubtedly the development of the Kasson soils has been influenced by the changing vegetation cycles. Either the prairie has encroached upon the forests, or the forests on the prairie. Observations suggest that the former is more probable, at least in some places. A forest cover affected the formation of the well-drained subsoils and the thin surface soils.

The Kasson soils are often underlain by heavy plastic till and, in some places, a prominent gravelly layer with some cobblestones is in the subsoil. Also, sand layers and pockets in the substratum are common in some areas. Probably the occurrence of this mixed material results from some complex mixing action of glaciers in the region, as the material is neither uniform nor continuous.

Profile description (Kasson silt loam):

0 to 6 inches, very dark gray silt loam; fine crumb structure.
6 to 9 inches, grayish-brown silt loam.
9 to 16 inches, brown heavy silt loam to clay loam; fine blocky structure.
16 to 25 inches, light olive-brown clay loam; yellowish-brown mottles; slightly plastic.
25 to 29 inches, olive-brown clay loam; pebble concentrate; reddish-brown mottles.
29 inches +, light olive-brown to yellowish-brown clay loam; acid.

These soils have a moderate to high moisture-holding capacity, and early in spring the nearly level areas are often wet. Internal drainage is slow to medium. The soils are moderately easy to conserve, and the erosion hazard is slight. The natural vegetation is principally prairie grasses, with intermingled scattered hardwoods (oak openings). The Kasson soils are less fertile than the associated Kenyon soils because they have less phosphorus, potassium, and organic matter. These soils especially need potassium.

Kasson silt loam, 0 to 1 percent slopes (Ka) (IIe–1).—This soil occurs on the smooth Iowan glacial till plain. The distribution of areas appears to be related to differences in parent material and vegetation.

Drainage is slightly restricted. Mottles are more numerous on the more nearly level areas, particularly on those that are adjacent to the more poorly drained Skyberg soil. Planting is often delayed in spring because of wetness.

Small grains, soybeans, corn, and legume-and-grass hay are grown on this soil.

Kasson silt loam, 2 to 6 percent slopes (Kb) (IIe–1).—This moderately well drained soil occurs on gently sloping to sloping areas adjacent to the upper drainageways of the Iowan glacial till plain. It contains less organic matter than Kasson silt loam, 0 to 1 percent slopes, and it is not so wet in spring. The surface soil is shallower than that of the Kenyon soils. The subsoil is more like that of forested soils than of soils developed under prairie grasses.

Seeding is seldom delayed on this soil because of extreme wetness. Internal drainage is slow to medium. Corn, small grains, soybeans, and legume-grass hay are the principal crops grown. Under good management, crop yields are generally fair to good. Erosion on the more sloping areas usually can be controlled easily by sound soil conservation practices.

Kato Soil

Kato silty clay loam (Kc) (IIw–2).—This is an inextensive, dark-colored, imperfectly drained prairie soil that developed from glacial outwash material. It occurs on outwash plains and terraces in the glaciated region, principally in the valleys of the upper Iowa River and along the larger tributaries of the Root River. It is associated with the Waukegan soils and differs from them chiefly in having a darker colored surface layer and a mottled subsoil. The soil is nearly level to gently undulating and commonly is in slight depressions on the outwash plain.

Profile description:

0 to 10 inches, black silty clay loam; medium granular structure.
10 to 20 inches, very dark grayish brown silty clay loam; plastic when wet.
20 to 35 inches, dark grayish-brown silty clay loam mottled with dark brown; very plastic when wet.
35 inches +, stratified, acid, fine, medium, and coarse sands and fine gravel.

The surface layer is darker and thicker than in the upland prairie soils. A substratum of sand and gravel generally lies at depths of 30 to 42 inches.

Runoff is very slow, and internal drainage is slow. The moisture-holding capacity is moderate, and the water table is often high, especially in spring. Little erosion occurs. Artificial drainage is needed in some areas, although the porous substratum makes the soil droughty in long dry periods.

Most areas are cultivated, and corn and small grains are the main crops grown.

Kenyon Soils

The most extensive prairie soils in the county developed from glacial till are the moderately well drained Kenyon soils. They are widely distributed but are most extensive in Bloomfield, Beaver, and York Townships. They are associated with the Racine and Ostrander soils but differ in having a deeper surface soil and a slightly mottled subsoil. They are most typically developed on the long gentle slopes of the Iowan till plain on slopes ranging from 1 to 6 percent. The profile is moderately developed and deep. The native vegetation was big bluestem and other tall prairie grasses.

Profile description (Kenyon silt loam):

0 to 13 inches, black to very dark gray heavy silt loam; medium granular structure.
13 to 23 inches, dark yellowish-brown silty clay loam; fine blocky structure.
23 to 36 inches, yellowish-brown clay loam with slightly mottled grayish brown; plastic when wet.
36 inches +, dark yellowish-brown acid clay loam (glacial till).

The texture of the surface soil ranges from silt loam to light silty clay loam.

Internal drainage is somewhat restricted in these soils, and permeability is moderate. The moisture-holding capacity is moderate to high. The more nearly level areas are sometimes wet early in spring, and seeding is often delayed.

The Kenyon soils are among the best in the county for agriculture. Practically all of the areas are cropped and are highly productive. Excellent yields of corn, small grains, soybeans, and hay are obtained.

Kenyon silt loam, 0 to 1 percent slopes (Kd) (I–1).—Generally this nearly level moderately well drained Kenyon soil is deeper to limestone bedrock than the Racine and Ostrander soils on similar relief. It is associated with them and differs in being mottled and in having a deeper surface soil.

This soil is highly productive and is one of the best agricultural soils in the county. Almost all areas are cropped, and high yields of corn, soybeans, small grains, and hay are obtained.

Kenyon silt loam, 2 to 6 percent slopes (Ke) (IIe–1).—This soil occurs on long slopes in the western part of the county. It is associated with other soils developed from Iowan glacial till.

The surface soil is dark-brown heavy silt loam about 10 to 15 inches thick. The subsoil is brown silty clay loam and extends to depths of 36 to 48 inches. The organic-matter content is higher than in the closely associated Kasson soils, but lower than in the Floyd and Clyde soils. Kenyon silt loam is generally porous, permeable to air, roots, and water, and high in moisture-holding capacity. Runoff is medium, and internal drainage is slightly restricted.

The soil is well suited to intensive cropping, and high yields are common. Corn, soybeans, small grains, and legume hay are the chief crops grown.

Lindstrom Soils

The Lindstrom soils are well-drained Prairie soils developed from loess in which there is an admixture of residual material. They are almost entirely in the eastern half of the county on the dissected uplands. They occur on talus slopes ranging from 5 to 25 percent in gradient. They are associated with the Tama and Downs soils and usually occur on slopes below them. They are also associated with the Chelsea and Boone mapping units.

The dark-colored surface soil ranges from 14 to 20 inches in thickness and from fine sandy loam to silt loam in texture. The texture depends upon the kinds of talus materials from which the soil was derived. The substratum often contains lenses and pockets of very fine sand.

Profile description (Lindstrom silt loam, uncultivated):

0 to 16 inches, very dark gray friable silt loam; fine granular structure.
16 to 24 inches, dark yellowish-brown silt loam; granular aggregates with dark organic coatings.
24 to 40 inches, yellowish-brown heavy silt loam; weakly developed, medium subangular blocky structure.
40 to 60 inches, yellowish-brown silt loam; medium to coarse subangular blocky structure; gritty.
60 inches +, light yellowish-brown silt loam; contains lenses and pockets of very fine sand; very gritty; massive.

The Lindstrom silt loams and fine sandy loams are mapped together. The silt loams have a moderate moisture-holding capacity and are not highly erodible. The coarser Lindstrom soils, the fine sandy loams, are not so extensive as the silt loams. They are somewhat excessively drained and have a moderately low moisture-holding capacity. They are on stronger slopes than the Lindstrom silt loams and are much more susceptible to erosion.

The more gently rolling areas of the Lindstrom soils are used for general farm crops, including corn, soybeans, and small grains. The stronger slopes are best suited to grass and are generally used for pasture.

Lindstrom silt loam and fine sandy loam, 2 to 6 percent slopes (La) (IIe–1).—The total acreage of these soils is very small, and individual areas are small. The Lindstrom fine sandy loam of this mapping unit occurs below sandstone outcrops. It is generally not so productive as the Lindstrom silt loam because of its erodibility and its lower moisture-holding capacity. The Lindstrom silt loam occurs where the loess is fairly thick. Usually there is no mixture of sand and loess. The profile of Lindstrom silt loam resembles that given for Tama and Downs soils, but ordinarily it has a deeper and darker surface layer.

These soils are well suited to cultivation and produce excellent crops of corn, soybeans, and hay.

Lindstrom silt loam and fine sandy loam, 7 to 11 percent slopes (Lb) (IIIe–1).—These soils are shallower and more extensive than the Lindstrom soils on gentler slopes. Lindstrom fine sandy loam, occurring on the upper slope range, is very erodible, and eroded spots and gullies are common. Special care is often needed to prevent erosion on these sandier areas.

These soils are moderately productive and under good management they can be kept so. They are well suited to crops and pasture.

Lindstrom silt loam and fine sandy loam, slightly or moderately eroded, 12 to 17 percent slopes (Lc) (IVe–1).—Erosion by water is potentially severe on these soils, and many areas are used only for pasture. Hay and other close-growing crops can be grown satisfactorily, but the best use probably is pasture.

Lindstrom silt loam and fine sandy loam, 18 to 45 percent slopes (Ld) (VIIe–1).—These soils are shallow and include more eroded areas than the other phases of the Lindstrom soils. Where fine sandy loam is dominant, some outcrops of sandstone occur.

Although erodible, many areas of these soils are only slightly eroded because they have been kept in pasture most of the time since the county was settled. The soils are not well suited to crops and should be used for pasture if possible. Greater returns over a long period will result if the soils are pastured. The pasture should be limed and reseeded occasionally, and phosphate should be applied.

Marshan Soil

Marshan silty clay loam (Ma) (IIIw–1).—This very poorly drained inextensive soil occurs mainly in the valley of the Upper Iowa River and its tributaries. It has developed from silty material deposited on stream terraces and outwash plains in the glaciated section of the western part of the county. It occupies nearly level to slightly depressed areas and is associated with the better drained Kato and Waukegan soils. The native vegetation is grasses; some sedges grow in the wetter areas.

Profile description:

0 to 10 inches, black silty clay loam; fine granular structure; slightly plastic.
10 to 17 inches, very dark gray silty clay loam, slightly mottled with strong brown.
17 to 25 inches, olive-brown silty clay loam mottled with dark brown; very plastic when wet; massive.
25 to 35 inches, light olive-brown silty clay loam; highly mottled; very plastic when wet.
35 inches +, grayish-brown, fine and medium sands with some fine gravel.

The surface layer varies in texture from a silt loam to a silty clay loam. Depth to the sand-and-gravel layer ranges from 30 to 42 inches. Runoff is very slow to ponded, and internal drainage is very slow. The soil receives seepage from adjacent uplands, and the water table is often high, particularly in spring. Undrained areas are now used chiefly for pasture. If this soil is drained, corn, soybeans, and hay can be grown.

Meridian Soils

The Meridian soils are well drained and light colored. They have developed from sandy deposits on stream terraces within the loess area in the eastern part of the county. The parent materials were derived mainly from sandstone, but there is an admixture of loess and limestone residuum. The soils occur almost entirely on the high terraces in the valley of Root River and its tributaries. Slopes range from 0 to 11 percent. The soils are associated with the terrace phases of the Fayette silt loams and with the Plainfield and Sparta loamy fine sands. The native vegetation consisted mainly of hickory, maple, oak, and other hardwoods.

Profile description (Meridian fine sandy loam):

0 to 3 inches, very dark grayish brown fine sandy loam.
3 to 10 inches, grayish-brown loam; weak platy structure.
10 to 15 inches, brown to dark-brown heavy loam; very fine blocky structure.
15 to 29 inches, dark-brown clay loam; fine blocky structure; plastic when wet.
29 inches +, light yellowish-brown medium to coarse stratified sand and fine gravel; sandier and more stratified with depth.

The Meridian soils differ from the Fayette silt loams in having a coarser surface layer and substratum, and from the Plainfield and Sparta loamy fine sands in having finer textured surface and subsoil layers. The Meridian soils vary mainly in the texture and development of the subsoil layer and in depth to the underlying stratified sand.

Runoff is slow to medium, internal drainage is medium, and the moisture-holding capacity is low to moderate. The soils are fairly easy to work, and the risk of erosion is slight.

Most areas have been cleared and cropped to corn, oats, and hay. Natural fertility is not high, but fair yields are obtained in normal years.

Meridian fine sandy loam, 0 to 1 percent slopes (Mb) (IIIs–1).—This soil is not extensive. A few small areas occur on high terraces along the streams. The soil is associated with Fayette silt loams, terrace phases, and with Plainfield and Sparta loamy fine sands. It has a moderately developed subsoil and a sandy and gravelly substratum.

This soil is not subject to erosion, because it is nearly level. Although not very fertile, it can produce fair yields of corn and small grains.

Meridian fine sandy loam, slightly or moderately eroded, 2 to 6 percent slopes (Mc) (IIIs–1).—Except for stronger slopes, this soil is similar to Meridian fine sandy loam, 0 to 1 percent slopes. Natural drainage is adequate, but on the stronger slopes of this soil runoff is rapid enough to cause some erosion.

Mixed Alluvial Land

Mixed alluvial land, 0 to 6 percent slopes (Md) (VIw–1).—This mapping unit includes mixed alluvial soils, some stony colluvium, and some fairly uniform soils of the bottom lands. The soils occur along or near frequently overflowing streams. Fresh sediments are deposited each time the valleys are flooded. Surface layers of these soils range from dark to light and from sand to clay. Drainage ranges from poor to excessive.

The areas are flooded so frequently—often several times a year—that this unit is not well suited to crops. Many areas are too narrow, irregular, and dissected by stream channeling to be used other than for pasture or timber. Where the land can be tilled, corn can be grown.

Mixed alluvial land, 7 to 17 percent slopes (Me) (VIIs–1).—This miscellaneous land type is on colluvial-alluvial materials. It occurs chiefly in the dissected sloping to moderately steep areas, normally along narrow V-shaped channels. These channels have cut down steep bluffs and rocky valley slopes. They contain colluvial deposits and have irregular surfaces. Rock rubble, alluvium, and mixed materials are carried down from the uplands. These narrow channels extend to the main drainage system or spread out fanwise where they empty onto the terrace benches or onto the valley floor.

This unit is not suited to crops because it is stony, uneven, and washes frequently.

Plainfield and Sparta Soils

The Plainfield and Sparta loamy fine sands have developed from wind-blown and water-laid sands on glacial outwash plains. They occur principally on high terraces and valley fills in the larger valleys. They are composed of quartz sands that contain a small percentage of silicates. Little difference in texture is evident throughout the profile.

The Plainfield soils are nearly level to undulating, light colored, and somewhat excessively drained. They have developed under a deciduous hardwood forest, chiefly oak. Permeability is very rapid, and internal drainage is rapid. The moisture-holding capacity is very low, and resistance to drought is poor. The fertility is low, and the soils are subject to severe wind erosion unless protected.

Profile description (Plainfield loamy fine sand):

0 to 3 inches, very dark grayish brown loamy fine sand.
3 to 15 inches, brown loose loamy fine sand.
15 to 35 inches, light yellowish-brown loose fine sand; contains some gravel.

The Sparta soils are distinguished from the Plainfield soils by the greater thickness and darker color of the surface layer. They have developed under prairie grasses but have a scattering of brush and small trees, mostly oaks. They occur on high terraces and valley fills. Like the Plainfield soils, they are somewhat excessively drained, rapidly permeable, and have a low moisture-holding capacity. Their fertility is also low.

The Plainfield and Sparta soils are grouped together because they generally are adjacent to each other, and their management problems and use are the same.

Plainfield and Sparta loamy fine sands, slightly or moderately eroded, 2 to 6 percent slopes (Pa) (IVs–2).—These soils are not extensive. They are located along the Root River, chiefly in the eastern half of the county near Rushford. They are very droughty, because they have a substratum of coarse sand. Many areas, particularly those on the gentler slopes, are used for corn, grain, truck crops, and pasture. Yields are often low in dry years. The principal management problems are improving the moisture-holding capacity and preventing wind erosion. This normally can be done by increasing the organic-matter content and by using supplemental irrigation.

Plainfield and Sparta loamy fine sands, eroded, 7 to 11 percent slopes (Pb) (IVs–3).—These soils occur on the slopes of terraces along the Root River. Their total acreage is small. The profiles are essentially like those of Plainfield and Sparta loamy fine sands occurring on 2 to 6 percent slopes. They differ from those soils in having more severe erosion. Severely eroded spots and gullies are scattered over the areas of these soils.

Plainfield loamy fine sand is very droughty and, because of the erosion hazard, it is not suited to cultivation. It would probably be best to grow pine trees on the poorest areas of this soil.

Sparta loamy fine sand makes up only a small percentage of this mapping unit.

This unit generally is not suited to the common field crops. Pasture and forest are best.

Peat and Muck

Peat and muck (Pc) (IIIw–4).—Organic soils, including Peat and muck, are not extensive in Fillmore County. Peat and muck occur principally in the western part of the county, in poorly drained depressions, in old abandoned channels and oxbows, and in seepage spots on the glacial uplands. Most of the Peat has formed from sedges, reeds, and grasses, partially decayed under a water table that is high much of the year. Peat is usually brown, fibrous, and spongy. Muck consists of black or very dark brown organic matter, much more decayed than in Peat. It is comparatively high in minerals.

Peat and muck are suitable for crops if properly drained and fertilized. Good crops of corn and vegetables are obtained on properly fertilized areas. These soils are generally deficient in potassium and phosphorus, and these should be applied. Hay mixtures of bromegrass, bluegrass, timothy, and alsike clover ordinarily do well.

Racine and Ostrander Soils

The Racine and Ostrander soils are well-drained Prairie soils or soils transitional between Prairie and Gray-Brown Podzolic soils. They have developed from medium-textured till of the Iowan glaciation. They occur on long uniform slopes of the Iowan till plain, generally on the more dissected areas. Slopes range from 0 to 17 percent. They are associated with the moderately well drained Kenyon, the imperfectly to poorly drained Floyd, and the very poorly drained Clyde soils. The mature drainage pattern indicates a somewhat mature physiography.

The Ostrander soils have formed under tall native prairie grasses. They have dark-colored surface layers and a relatively high content of organic matter.

Profile description (Ostrander silt loam):

0 to 13 inches, very dark gray silt loam; fine granular structure.
13 to 17 inches, dark grayish-brown friable silt loam; very fine blocky structure.
17 to 22 inches, brown heavy silt loam; fine to medium blocky structure.
22 to 32 inches, yellowish-brown clay loam; medium blocky structure.
32 to 36 inches, brownish-yellow slightly plastic clay loam; faint mottles.
36 inches +, yellowish-brown acid clay loam (glacial till).

The Racine silt loam has a profile similar to that of the Ostrander silt loam and developed on identical parent material.

The Racine soils are transitional between the Ostrander, a Prairie soil, and the Renova, a Gray-Brown Podzolic soil. They differ from the Ostrander soils in having a slightly lighter colored and thinner surface soil layer that lies over a grayish-brown subsurface layer. The natural vegetation consisted mainly of oaks and other mixed hardwoods, although in a few scattered openings prairie vegetation was common. The Racine soils are better suited to forest than the Ostrander.

Racine and Ostrander soils are generally fairly shallow. They occur on rather thin deposits of glacial till—in places only 2 to 4 feet thick. Included with these soils are areas of the deep phase of the Rockton soil, which is underlain by limestone bedrock at depths of 24 to 36 inches. Agriculturally, these thinner Racine and Ostrander soils are not so valuable as the associated upland soils on deeper glacial till deposits. They are less productive than the deep, well-drained Prairie soils in adjacent counties that have developed on Iowan glacial till. Corn, oats, flax, soybeans, and hay are grown, however. Except on the shallower areas in years of subnormal rainfall, fairly good yields are obtained.

Racine and Ostrander silt loams and loams, 0 to 1 percent slopes (Ra) (I–1).—These soils are widely distributed over the glaciated broad upland flats. Many areas are fairly large. Sinkholes, characteristic of areas underlain by soluble limestones, are common. Although the relief is nearly level, these soils have good surface and internal drainage because of underground passages and sinks. Runoff is slow, and almost no erosion occurs. Most areas are cropped to corn, soybeans, small grains, alfalfa, and grass hay. Under good management, yields are generally good. It is important to fertilize these soils, keep them in good tilth, keep up the organic-matter content, and lime them for legumes.

Racine and Ostrander silt loams and loams, 2 to 6 percent slopes (Rb) (IIe–1).—These are the most extensive of all the Racine and Ostrander soils. They occupy long smooth slopes. The Racine soils have an average surface-soil thickness slightly less than that of a furrow slice. The Ostrander surface soil is deeper. In this unit, texture of surface soil varies from loam to silt loam, but silt loam predominates. Water erosion is a slight hazard. Management practices to help keep these soils highly productive should include using proper rotations, adding fertilizer, liming for legumes, applying farm or green manure, and using supplemental practices to control erosion. Good yields on these soils are common.

Racine and Ostrander silt loams and loams, eroded, 2 to 6 percent slopes (Rc) (IIe–1).—These soils are less extensive than the uneroded Racine and Ostrander soils on 2 to 6 percent slopes. They have lost much of their surface soil through erosion. Small eroded spots and scattered gullies occur on many areas, particularly on narrow ridges and on the stronger slopes. The surface soil is much thinner and the texture often finer than that of the uneroded Racine and Ostrander soils on 2 to 6 percent slopes.

The use and management resemble those of the uneroded phases, but these soils need erosion control to reduce soil losses. If they are used for row crops, contour plowing and stripcropping should be practiced.

Racine and Ostrander silt loams and loams, eroded, 7 to 11 percent slopes (Rd) (IIIe–1).—These soils occur mostly in the more sloping uplands. Erosion has caused considerable soil losses in some areas, and more careful consideration needs to be given to its control than on the milder slopes. Yields are somewhat lower than on the smoother, less eroded slopes. Many areas that have been badly damaged by erosion should not be cropped. If these soils are used for row crops, contour plowing, stripcropping, or terracing is needed to prevent further loss of soil material. Legumes and grasses should be grown in the rotations. Pastures are better for badly eroded areas.

Racine and Ostrander silt loams and loams, eroded, 12 to 17 percent slopes (Re) (IVe–1).—These soils occupy the ridges along drainageways in the general area of the moderately steep glacial uplands. They are generally associated with Rockton and Dodgeville soils, and with Sogn soils near the upland escarpments. The individual areas are long and narrow. These soils have heavier and thinner surface layers than the other Racine and Ostrander soils. Gullies and eroded spots are more common.

The soils are largely used for hay and pasture because of the serious erosion hazard. Row crops would increase the soil losses, and yields would be low. Sound erosion control practices need to be used and, in addition, improvement of organic-matter and plant-nutrient levels to increase the productivity of the soils for hay and pasture.

Renova Soils

Renova soils are well-drained Gray-Brown Podzolic soils developed from Iowan glacial till of variable thickness over limestone. The soils have formed under forest on nearly level to moderately steep slopes (0 to 17 percent). They differ from the Racine and Ostrander soils in having lighter colored and thinner surface layers. They are associated with the Sogn soils and with the Dubuque and Whalan soils. Some areas of Dubuque and Whalan soils are included in the mapping units. Areas of Renova soils are usually along streams or on dissected uplands.

Profile description (Renova silt loam):

0 to 2 inches, very dark grayish brown silt loam.
2 to 8 inches, grayish-brown silt loam; fine platy structure.
8 to 18 inches, dark yellowish-brown silty clay loam; fine blocky structure; plastic when wet.
18 to 30 inches, dark-brown silty clay loam; medium blocky structure; plastic when wet.
30 to 39 inches, dark yellowish-brown clay loam; medium to coarse blocky structure.
39 inches +, dark yellowish-brown acid clay loam (glacial till); massive.

Runoff is medium to rapid on these soils, and they are considerably eroded on the stronger slopes. Erosion is potentially very severe on those slopes. Permeability is moderate, and the moisture-holding capacity is enough for most plants. The plant-nutrient content is moderate. The soils are difficult to conserve.

The original vegetation was oak, hickory, and other hardwoods. Most areas have been cleared and are cropped chiefly to corn, soybeans, small grains, and hay. The stronger slopes are used for timber and pasture.

Renova silt loam and loam, 0 to 1 percent slopes (Rf) (I–1).—These soils occur on nearly level glacial uplands in association with Dubuque and Whalan soils. They are not so extensive as the Renova soils on more sloping relief. They resemble the Gray-Brown Podzolic soils in Wisconsin and Michigan. The profile has a light-colored surface layer, a dark-brown well-developed subsoil, and a partially weathered substratum of glacial till. Limestone bedrock occurs at depths ranging from 30 inches to 6 feet. The texture of the surface soil is generally silt loam, but in some areas the surface soil contains enough coarse material to be classified as loam. Internal drainage is good in the surface soil and upper subsoil but is often somewhat impeded by the fine-textured limestone residuum in the substratum.

The soils developed under hardwood forest. Because the organic-matter content in the surface layer is lower, they are not so productive as the Racine and Ostrander soils that developed under prairie vegetation. Nevertheless, these soils are suitable for most commonly grown crops, including corn, soybeans, small grains, and hay.

Renova silt loam and loam, 2 to 6 percent slopes (Rg) (IIe–2).—These soils occupy divides between drainageways and are well distributed throughout the glacial till plain. They are usually deeper than Renova silt loam and loam, 0 to 1 percent slopes. Limestone bedrock, in most places, is at depths of more than 5 feet.

Internal drainage in this mapping unit is moderate. Runoff is slight, but on the stronger slopes the soils are erodible. Stripcropping, contour tillage, and terracing are the principal erosion control measures needed to reduce soil losses. The moisture-holding capacity is moderate. The soils are fairly easy to work, and they respond fairly well to good management. If crops are properly rotated, fertilizers are added, and soil conservation is practiced, corn, soybeans, small grains, and hay do well.

Renova silt loam and loam, eroded, 2 to 6 percent slopes (Rh) (IIe–2).—These soils are well distributed in the glaciated section and are the most extensive of the Renova soils. Erosion has removed 25 to 75 percent of the surface soil and has made some gullies.

Erosion limits the productivity of this mapping unit, and it is often impractical to cultivate some of the badly eroded areas. Chiefly small grains and hay are grown or the areas are used for pasture.

Renova silt loam and loam, eroded, 7 to 11 percent slopes (Rk) (IIIe–1).—In many places, particularly on the steeper areas adjacent to streams, erosion has removed the silt loam or loam surface soil and exposed the fine-textured, yellowish-brown subsoil. This has caused poor tilth and lowered fertility. On the stronger slopes, shallow gullies commonly dissect the surface. Yields are generally low on these areas. Badly eroded areas are best suited to hay and pasture. Row crops should not be grown on them.

Renova silt loam and loam, eroded, 12 to 17 percent slopes (Rl) (IVe–1).—These soils occur on moderately steep areas adjacent to the larger streams in the glacial till plain. They are not so extensive nor so widely distributed as the Renova soils on gentler slopes, and they are not nearly so productive. Except in protected wooded areas or in permanent pastures, much of the surface soil and some of the subsoil have been removed through erosion.

A satisfactory seedbed is often difficult to prepare, because tilth is poor and the surface soil is extremely low in organic matter. Severe erosion makes it impractical to cultivate these soils. The soils are better suited to hay and pasture than to row crops.

Rockton and Dodgeville Soils

Limestone bedrock underlies the Rockton and Dodgeville soils at depths of 1 to 2 feet. The lower subsoil of these Prairie soils always includes material weathered from limestone. The soils are intermediate in depth between the very shallow Sogn soils and the Racine and Ostrander soils. Normally they occupy narrow strips on gentle to steep slopes. They are associated with the major upland soils.

The Rockton soils have developed from thin deposits of glacial till. Fairly level areas of these soils are common on the broad upland divides, and sinkholes are numerous.

Profile description (Rockton silt loam):

0 to 8 inches, dark-gray silt loam; fine granular structure.
8 to 15 inches, dark yellowish-brown heavy silt loam to clay loam; medium blocky structure.
15 to 22 inches, yellowish-brown grading to reddish-brown clay loam till, mixed with weathered limestone; fragments of rock common.
22 inches +, limestone bedrock.

The Dodgeville soils have developed from loess. They differ from the Dubuque and Whalan soils in having a thicker, dark-colored surface soil and upper subsoil. Also, their layers are much less distinct throughout.

The Rockton and Dodgeville soils need about the same management, even though they developed from different parent materials. Areas on steep slopes are difficult to work. Erosion is often severe on the steep slopes, and soil losses are considerable. Preventive measures should be taken to reduce losses. Rotations that consist dominantly of hay or pasture are suggested. The moisture-holding capacity is below normal because of shallowness, so these soils do not produce nearly so well as the deeper Tama and Downs soils or the Racine and Ostrander soils.

Rockton and Dodgeville silt loams, shallow, 2 to 6 percent slopes (Rm) (IIIe–2).—The more gently sloping areas of these soils (slopes of 2 to 3 percent) are commonly very shallow, and sinkholes are a conspicuous part of the landscape. Slopes of more than 3 percent are erodible, and measures for erosion control should be taken if the soils are planted to row crops.

These soils developed under grass and are fairly productive if properly managed. They are commonly used for corn, small grains, hay, and pasture.

Rockton and Dodgeville silt loams, shallow, eroded, 2 to 6 percent slopes (Rn) (IIIe–2).—These soils have lost some of their surface soil through erosion. The surface soil is usually thinner and often finer than in the uneroded Rockton and Dodgeville phases. These soils are generally downslope from the associated Racine and Ostrander soils of the glacial and loessal uplands.

To control erosion, contour plowing, stripcropping, and proper rotation of crops are essential. Yields are normally lower than on the associated uneroded and thicker soils.

Rockton and Dodgeville silt loams, shallow, eroded, 7 to 11 percent slopes (Ro) (IVe–2).—Erosion has been fairly severe in some areas of these soils. If they are planted to row crops, erosion control is needed to check further losses. Stripcropping and contour cultivation, as well as growing legumes and grasses longer in the rotation, will help control erosion. The severely eroded areas should be used only for pasture.

Rockton and Dodgeville silt loams, shallow, eroded, 12 to 17 percent slopes (Rp) (VIe–1).—These soils are associated with the Sogn soils and with Steep rocky land. Because of steep slopes and shallowness, they should not be cultivated. They are best suited to forest or to limited grazing.

Rockton and Dodgeville silt loams, shallow, 18 to 35 percent slopes (Rr) (VIIe–1).—These soils occur in highly dissected areas on steep slopes. Because of steep slopes and the erosion hazard, few areas are cultivated. The soils are best suited to pasture or trees. Wooded areas should be protected from fire and grazing. Pastures should not be overgrazed.

Schapville Soils

The Schapville soils are somewhat poorly drained to moderately well drained Prairie soils that occupy conspicuous upland benches. They have developed on a thin mantle of loess that overlies residuum derived from calcareous shales. The thickness of the loess varies but usually is less than 12 inches.

The acreage is limited and confined to areas where shale outcrops. Water flowing from the horizontally bedded shale forms many seep spots and springs.

The profiles of these soils are well developed. The texture of the surface soil varies from silt loam to silty clay loam, depending on the amount of loess mixed with the shaly residuum.

Profile description (Schapville silty clay loam):

0 to 9 inches, black plastic silty clay loam; fine granular structure.
9 to 12 inches, very dark gray silty clay loam.
12 to 16 inches, very dark grayish brown silty clay loam.
16 to 26 inches, light olive-brown silty clay loam; mottled.
26 to 31 inches, olive-gray to olive silty clay loam.
31 to 48 inches, olive shaly residuum of silty clay texture; calcareous.

The soils are medium in content of plant nutrients and have a fairly high moisture-holding capacity. They are very sticky when wet, hard when dry, and often difficult to work. They developed under prairie vegetation and some mixed hardwoods. Now they are used for general farm crops and pasture.

A few areas of very wet sticky soils derived from shale are included in the Schapville mapping units.

Schapville silt loam and silty clay loam, 2 to 6 percent slopes (Sa) (IIIw–5).—These inextensive soils occupy fairly smooth slopes on upland shale benches, mainly in the loess-covered areas. A few large areas occur in the eastern part of the county. The surface soil is very silty in some places; in others it contains considerable clay, because of the shale influence.

The gentler slopes, although difficult to work, are fairly productive of general farm crops. Erosion is not a problem, but some eroded areas are included in the mapping unit. Seepage spots, in some places, and the high moisture-holding capacity make the soils wet. Some form of artificial drainage is normally needed for most crops.

Schapville silt loam and silty clay loam, 7 to 11 percent slopes (Sb) (IVe–2).—Because it is on narrow rims around the upland shale benches, areas of these soils are generally small. The soils are not so wet as Schapville silt loam and silty clay loam, 2 to 6 percent slopes. Erosion is active on the stronger slopes of this unit.

Schapville silt loam and silty clay loam, slightly or moderately eroded, 12 to 17 percent slopes (Sc) (VIe–1).—This mapping unit is on the moderately steep slopes of upland shale benches. Seeps and springs are common.

Because of steep slopes and seep areas, these soils are not suited to crops. They are best suited to pasture or woodlots.

Seaton and Port Byron Soils

Seaton and Port Byron soils have developed from deep, coarse-textured Peorian loess deposits. They commonly occupy ridges and isolated dunelike hills or knolls surrounded by glacial till soils. Such topographic features are commonly called paha and are generally along the loess-glacial drift border in both Minnesota and Iowa. Some areas of these soils occur within the loess-covered zone.

These soils have a coarser subsoil and substratum than the associated Fayette soils or the Tama and Downs soils.

Profile description (Seaton silt loam):

0 to 4 inches, very dark grayish brown silt loam.
4 to 10 inches, grayish-brown coarse very friable silt loam.
10 to 14 inches, dark-brown very friable silt loam.
14 to 30 inches, brown friable silt loam.
30 to 50 inches, yellowish-brown very friable very fine sandy loam.

The light-colored Seaton soils have formed from coarse loess, under a forest cover. The loess is calcareous at depths of 40 to 60 inches. The Port Byron soils are Prairie soils formed from the same materials as the Seaton soils, but they have darker and thicker surface layers than the Seaton. The calcareous deposits are somewhat nearer the surface than in the Seaton soils—generally at depths of 30 to 50 inches.

These soils are very erodible, and after heavy rains, deep, almost vertically sided rills develop. This kind of erosion is common on deep loess deposits.

Many areas of these soils are forested. Cleared areas are cropped to corn, small grains, and hay. Generally these soils are not so productive as the associated soils developed on deep loess. Since the total acreage is small, these two soils are mapped together for convenience in discussing their use and management.

Seaton and Port Byron silt loams, eroded, 2 to 6 percent slopes (Sd) (IIe–2).—These inextensive soils are very erodible because they are very friable. They differ from the associated Fayette soils in having a coarser and calcareous substratum and less structural development. They are potentially more erodible than the Fayette soils. Erosion should be prevented.

Seaton and Port Byron silt loams, eroded, 7 to 11 percent slopes (Se) (IIIe–1).—Unless conservation measures are taken, these loose, coarse loess soils will erode severely if cultivated. Already, much of the surface soil and subsoil have been lost through erosion. Further losses should be prevented by contour tillage, stripcropping, and proper rotation of crops.

Seaton and Port Byron silt loams, eroded, 12 to 17 percent slopes (Sf) (IVe–1).—Because of strong slopes and erosion, these soils are not suited to row crops. The only places that are relatively uneroded are the forested areas that have never been cleared. The chief management practices needed on these soils are curbing spread of severely eroded spots and keeping up the tilth and the content of plant nutrients. The soils should be used only for pasture or forest.

Skyberg Soil

The somewhat poorly drained and poorly drained Skyberg soil is a transitional soil developed in a region predominantly occupied by Prairie soils but in which influence of both tree and grass vegetation has been felt. The original vegetation was tall prairie grasses and some hardwoods. The Skyberg soil is generally underlain by a rather compact plastic till of the Iowan or an earlier glaciation.

Profile description (Skyberg silt loam):

0 to 7 inches, very dark grayish brown friable silt loam.
7 to 12 inches, grayish-brown silt loam, mottled with dark yellowish brown.
12 to 18 inches, dark grayish-brown heavy silt loam, mottled with dark yellowish brown; blocky structure.
18 to 27 inches, light-gray clay loam, mottled with olive brown; blocky peds coated with light gray.
27 inches, light brownish-gray, very plastic, acid silty clay loam (glacial till).

The Skyberg soil differs from the Floyd and Clyde soils in having a lighter colored and thinner surface layer and a more highly plastic and compact subsoil and substratum. In many respects the Skyberg soil resembles a Planosol, but it is somewhat less developed than a Planosol and has a thinner solum. The subsoil has many features usually associated with forested soils—well-developed structure, very plastic and sticky consistence, and abrupt horizon boundaries. The surface soil, however, is more representative of that of the Prairie soils. It is very dark and much thicker than the average surface layer of a Gray-Brown Podzolic soil. In places the subsurface soil is well developed and comparable to those of forested soils. The forest possibly has encroached in these areas, for the Skyberg soil has characteristics more like forested soils than Prairie soils. The influence of forest vegetation is evident (fig. 5).

Figure 5.—Profile of Skyberg silt loam.

The Skyberg soil is much less permeable than the associated soils that developed from the common Iowan glacial till. Its surface drainage is poor, and internal drainage is slow.

Skyberg silt loam, 0 to 3 percent slopes (Sg) (IIIw–2).—Natural fertility is moderately low on this soil, and the potassium content is particularly low. The soil is acid throughout and needs lime. The water table is often high in spring, and planting of crops is sometimes delayed. The soil is used largely for corn, small grains, soybeans, and hay. Fair yields are obtained in dry seasons, but in wet years yields are often low.

Sogn Soils

The Sogn soils are nearly level to moderately steep, very shallow, dark-colored Lithosols that developed on residuum from limestone and shale. They usually occupy narrow strips, which are commonly between the Rockton and Dodgeville mapping units and Steep rocky land. Rock outcrops and chert and stone fragments are common on the surface and throughout the soil. The parent material is at depths of less than 12 inches.

The soils are very thin and are not well developed. They vary considerably in thickness over parent rock and in quantity of chert and limestone fragments on and within the profile. In many places the dark-colored surface soil rests almost directly on the parent material. Thin deposits of glacial till or loess cover most areas.

Profile description (Sogn silt loam):

0 to 6 inches, very dark grayish-brown silt loam; limestone fragments are common.
6 to 10 inches, dark grayish-brown clay loam to silty clay loam.
10 inches +, very plastic clay loam to silty clay (limestone and shale residuum).

Although both trees and grass grow on Sogn soils, the grasses have had little influence on the development of the profile, other than imparting the dark color to the surface layer. The soils are well suited to redcedar, which is conspicuous in the landscape.

Almost none of the acreage is cultivated. The lower slopes are in forest or in prairie grasses. The soils occupy such small narrow areas that few methods for improvement are practical.

Sogn silt loam, 0 to 6 percent slopes (Sh) (IVe–2).—This shallow soil occurs on the nearly level to gently sloping uplands. It is associated with the Dubuque and Whalan soils and with other soils of the uplands. Stone fragments on the surface interfere with tillage. Limestone and shale bedrock within 12 inches of the surface interfere with cultivation or limit the suitability of the soil for most crops. The soil is best used for pasture.

Sogn silt loam, eroded, 7 to 11 percent slopes (Sk) (VIe–1).—This soil has lost much of its surface soil through runoff. Because it is shallow, droughty and eroded, and has unfavorable slopes, the soil is poor for row crops. It furnishes limited grazing.

Steep Rocky Land

Steep rocky land (Sl) (VIIe–1).—Steep rocky land is a miscellaneous land type that includes all lands too steep to cultivate. The areas have either a very thin layer of soil material or many outcrops of limestone and sandstone bedrock. The thin layer of soil material overlying bedrock lacks the characteristics of a soil. Large areas of Steep rocky land are along the Root River and its larger tributaries. The land type occurs on the dissected uplands in bands of varying width, steepness, and height. It includes escarpments and ledges that form dividing lines between uplands and valley fills, uplands and bottom lands, terraces and bottom lands, and uplands and bedrock benches. Some of the most prominent ledges are below the rims of small, almost circular buttes. These bedrock ledges are the result of weathering of various kinds of rocks through the ages. They are 50 to 150 feet above the uplands. Bedrock escarpments and ledges rim the large valleys, particularly in the eastern part of the county. In places there are precipitous cliffs.

Most areas of Steep rocky land are forested. The growth consists mostly of maple, ash, basswood, oak, redcedar, elm, and poplar. The more protected slopes produce some pasture. Many ledges of rock have been quarried, and several large quarries are still worked.

Tama and Downs Soils

The Tama and Downs soils have developed under both trees and grasses from Peorian loess deposits. They occur in the uplands on nearly level to steep slopes, but generally they are on gentle slopes of 2 to 5 percent. They occupy the smooth broad divides in dissected areas flanked by moderately deep drainage channels, which are largely part of the Root River drainage system. They occur also on lower valley slopes and on loess-covered benches. In some places they are underlain by limestone bedrock and in others by sandy and gravelly material at depths of 3 to 5 feet.

The Tama soils are dark-colored Prairie soils developed from Peorian loess under the dominant influence of prairie grasses, chiefly big bluestem. They occupy the broad flat divides between streams in the loessal uplands.

Profile description (Tama silt loam):

0 to 17 inches, very dark brown friable silt loam; fine granular structure.
17 to 22 inches, dark-brown, friable, heavy silt loam.
22 to 40 inches, dark yellowish-brown to yellowish-brown silty clay loam; well-developed fine to medium subangular blocky structure.
40 to 70 inches, yellowish-brown light silty clay loam; medium to coarse blocky structure.
70 inches +, light yellowish-brown heavy acid silt loam (loess); massive structure.

The Downs soils are transitional soils occupying areas in the ecological tension zone between light-colored soils developed under forest (Fayette soils) and dark-colored soils developed under prairie grasses (Tama soils). They differ from the Fayette soils in having a darker and thicker surface layer and a subsurface layer that is often slightly gray and not so well developed. The Downs soils differ from the Tama soils in having lighter colored and thinner surface layers. They usually occur on stronger slopes.

The Tama and Downs soils are well drained and moderately permeable. They are very silty, especially in the surface layer. The moderately developed subsoil has a silty clay loam texture and weakly developed medium subangular blocky structure. The moisture-holding capacity is moderate to high, depending upon the clay and organic-matter content. The content of plant nutrients is moderate to moderately high. Erosion is slight, except on the more rolling areas, where it is moderate.

Most areas of Tama and Downs soils produce well and respond to good management. They are used chiefly to grow corn, small grains, and alfalfa, clover, and other hay.

The use and management are usually the same for both the Tama and the Downs soils, and they occur in very close association. They are therefore mapped together.

Tama and Downs silt loams, 0 to 1 percent slopes (Ta) (I–1).—These soils occur mainly in the eastern part of Fillmore County. Except for the deeper surface layer and darker color, the profile resembles that of other Tama and Downs silt loams.

The soils are very productive, and yields are as high as on any soil in the county. Management is easy, and productivity can be kept at a high level. Excellent yields of corn, soybeans, oats, alfalfa, and clover are obtained.

Tama and Downs silt loams, 2 to 6 percent slopes (Tb) (IIe–1).—This is the most extensive of the Tama and Downs mapping units. Generally the soils occupy gentle slopes of less than 4 percent on the broad divides of the loess-covered uplands. The areas are widespread, though most common in Harmony, Canton, and Newburg Townships. The surface soil ranges from 6 to 18 inches in thickness and is dark to moderately dark.

These soils are very productive and are used almost entirely for crops. Good yields of corn, soybeans, oats, alfalfa, clover, and timothy hay are obtained. The soils are easy to keep highly productive. Suitable rotations are used, and lime, phosphate, and organic matter are added. Waterways should be kept in grass, and contour cultivation practiced, especially on the more sloping areas.

Tama and Downs silt loams, eroded, 2 to 6 percent slopes (Tc) (IIe–1).—These soils differ from the uneroded phases of Tama and Downs silt loams in having a thinner surface layer and more signs of sheet erosion. Most of the erosion is on the stronger slopes.

Because of erosion, management practices are more exacting than for the uneroded phases. Crop yields are slightly lower. Care should be taken to control erosion.

Tama and Downs silt loams, 7 to 11 percent slopes (Td) (IIIe–1).—These soils have apparently either been in pasture or have been well managed, because they do not show signs of erosion. They usually occur along the breaks of the upland divides where slopes are generally steep.

These soils are very productive, and good yields of general crops are obtained. Management practices should include proper rotation of crops and the addition of organic matter, lime, and commercial fertilizer where needed. Control of erosion is necessary if these soils are to be kept at a high level of productivity.

Tama and Downs silt loams, eroded, 7 to 11 percent slopes (Te) (IIIe–1).—Erosion has removed much of the surface layer of these soils, and in some places the subsoil is exposed. Prevention of further erosion is the chief management problem. If these soils are used for pasture or hay, erosion control is fairly simple. If row crops are grown, it is best to use contour tillage, stripcropping, terracing, and grassed waterways.

Tama and Downs silt loams, 12 to 17 percent slopes (Tf) (IVe–1).—These soils are not suited to row crops, and most areas have been pastured for many years. They erode if used for crops requiring tillage. They should be seeded to a pasture mixture that includes legumes, and grazing should be carefully controlled to keep a good sod.

Tama and Downs silt loams, eroded, 12 to 17 percent slopes (Tg) (IVe–1).—Much of the surface layer of these soils has been lost through erosion. Because of strong slopes and erosion, these soils are not suited to corn or other row crops. They are best suited to hay or pasture. Under cultivation runoff is rapid and soil and water losses are great. Erosion control is needed, as well as other practices that will keep a good sod.

Tama and Downs silt loams, severely eroded, 12 to 17 percent slopes (Th) (VIe–1).—These soils are severely eroded, and prevention of further erosion is the chief management problem. Generally these soils were cleared, used for row crops until yields were low, and were then abandoned or used for pasture. The soils are suited to pasture if erosion can be checked and pasture grasses can be established.

Tama and Downs silt loams, 18 to 35 percent slopes (Tk) (VIe–1).—These soils have steeper slopes and more exposed subsoil than the other phases of Tama and Downs silt loams. They are associated with other soils developed on loess in the highly dissected uplands, mainly in the eastern part of the county. Some moderately eroded areas are included in this mapping unit.

These soils are not suited to row crops, and pastures are normally poor. They can be used for grazing, if grazing is controlled and the pastures are improved.

Thurston and Wykoff Soils

The Thurston and Wykoff loams are well drained to somewhat excessively drained, moderately deep soils of the uplands. They generally occur on knolls and morainic hills, and they range from nearly level to rolling. The soils have developed from stratified coarse sand and gravel on the glacial drift plain. They differ from the Dickinson soils in having fine gravel and small cobbles in the subsoil and in having a predominantly gravelly rather than a sandy substratum. Gravel is at depths of 2 to 3 feet. The gravelly parent material is used for road construction.

The areas of these soils are small and widely distributed. Most of the acreage is near Ostrander and near the iron mines. Thurston and Wykoff soils are mapped together because their use and management are the same. The mapping units, or soil phases, belong to two soil types—loams and sandy loams.

The Thurston loams are Prairie soils that developed under grass from gravelly material. They have a dark-colored fairly thick surface layer, and a moderately developed subsoil containing fine gravel in the lower part. The substratum is stratified yellowish-brown glacial sandy gravel. The upper layers resemble those of the Racine and Ostrander soils.

Profile description (Thurston loam, moderately deep):

0 to 10 inches, very dark grayish brown loam; fine granular structure.
10 to 17 inches, dark-brown slightly plastic heavy loam.
17 to 25 inches, dark yellowish-brown slightly compact gravelly loam; weak blocky structure.
25 to 40 inches, light yellowish-brown gravelly loamy sand.
40 inches +, dark yellowish-brown coarse sand and gravel.

The Wykoff loams are light-colored Gray-Brown Podzolic soils that developed under forest from gravelly material. Except for their light-colored surface soils, they are similar to the Thurston loams.

The Thurston and Wykoff loams have good to somewhat excessive surface drainage and medium to rapid internal drainage. Their moisture-holding capacity is low to moderate. The soils are somewhat droughty, but ordinarily they hold moisture better than the Dickinson soils.

The Thurston and Wykoff loams are used for corn, small grains, and hay, but yields are frequently low because of drought.

The Thurston and Wykoff sandy loams have developed from much the same kind of parent material as the Thurston and Wykoff loams. They also occur on the glacial uplands on knolls and morainic hills. They are associated with the more extensive glacial till soils. They differ from the Thurston and Wykoff loams in having a shallower depth to the substratum and a coarser textured surface soil and subsoil. The gravel-and-sand substratum is at a depth of less than 2 feet.

Profile description (Thurston sandy loam, shallow):

0 to 7 inches, very dark grayish-brown friable sandy loam.
7 to 17 inches, dark yellowish-brown slightly plastic loam; fine blocky structure.
17 to 30 inches, yellowish-brown, loose, gravelly loamy sand.

These sandy loams are slightly more droughty than the Dickinson soils. They are used for the same crops as the Thurston and Wykoff loams, but yields are generally lower because the sandy loams are more droughty.

Thurston and Wykoff loams, moderately deep, 0 to 1 percent slopes (Tl) (IIe–3).—Most areas of these soils are small, and generally they are in the extreme western part of the county. Droughtiness limits crop production, although these soils hold moisture better than the associated Dickinson soils and the Thurston and Wykoff sandy loams. General farm crops are grown, and yields are frequently low in dry seasons.

Thurston and Wykoff loams, moderately deep, eroded, 2 to 6 percent slopes (Tm) (IIe–3).—Gravel in the substratum of these soils increases their droughtiness. Some of the surface soil has been lost through erosion. Crop yields are slightly lower than on the associated soils.

Thurston and Wykoff loams, moderately deep, eroded, 7 to 17 percent slopes (Tn) (IVe–1).—These soils are not so droughty as the coarser Thurston and Wykoff soils. Surface drainage is good to excessive, and internal drainage is excessive. Because they are eroded, droughty, and on strong slopes, these soils are not suited to row crops. Hay and pasture are better.

Thurston and Wykoff sandy loams, shallow, 0 to 1 percent slopes (To) (IIIs–1).—These soils occur on the nearly level areas on the glacial moraines and gravel knobs adjacent to the glacial till soils of the uplands. They differ from the Thurston and Wykoff loams, moderately deep, in having their substratum nearer the surface—usually less than 2 feet. Droughtiness is the principal management problem. Row crops are often damaged by drought.

Thurston and Wykoff sandy loams, shallow, eroded, 2 to 6 percent slopes (Tp) (IIIs–1).—These soils generally occur around the edges of the nearly level ridgetops on the glaciated uplands. They are not ordinarily well suited to row crops, because of erosion, low moisture-holding capacity, and gravelly subsoil. With good management, however, that includes erosion control practices, they will produce fair yields of corn, grain, and hay.

Thurston and Wykoff sandy loams, shallow, eroded, 7 to 11 percent slopes (Tr) (IVs–1).—These soils are associated with other phases of Thurston and Wykoff soils but are not so extensive. Measures to reduce droughtiness or to increase productivity are not effective on these soils. The soils are best suited to hay and pasture.

Waukegan Soils

The Waukegan series consists of well-drained, dark-colored soils. They have developed under prairie grass from silty materials in the glacial outwash deposits on the terraces. Possibly some loess or alluvial silt has been deposited on them. The total acreage of these soils is not large, and they are mostly in the larger outwash valleys, generally from 5 to 50 feet above the flood plain. These soils are nearly level to gently undulating; slopes range from 0 to 6 percent.

Profile description (Waukegan silt loam):

0 to 15 inches, very dark grayish brown friable silt loam.
15 to 22 inches, dark-brown heavy silt loam.
22 to 33 inches, brown to dark-brown silty clay loam; well-developed blocky structure.
33 to 40 inches, dark yellowish-brown light silty clay loam.
40 inches +, dark-brown, acid, medium to coarse sand and fine gravel; stratified glacial outwash.

The depth to underlying sand and gravel varies from 36 to 42 inches.

The surface layers are dark, thick, and silty. Waukegan soils have good internal drainage, moderate to rapid permeability, and adequate water-holding capacity.

Almost all the acreage is cropped. Except in the dry seasons, good yields of corn, oats, soybeans, and hay are obtained.

Waukegan silt loam, 0 to 1 percent slopes (Wa) (I–1).—This soil occurs along the larger streams on glacial outwash terraces. Drainage is good, permeability is moderate to rapid, and the moisture-supplying capacity is generally adequate. Crops do well on this soil if rainfall is adequate and well distributed throughout the growing season. Water is readily absorbed, and there is practically no runoff; hence, little soil is lost through erosion.

Above-average yields of corn, oats, soybeans, and hay are obtained in good seasons.

Waukegan silt loam, 2 to 6 percent slopes (Wb) (IIe–1).—Erosion is common on the stronger slopes near the outer edge of the outwash plain, where this soil generally occurs. Crops, rotations, and erosion control practices suitable for this soil are discussed in the section on use and management.

Use, Management, and Productivity of Soils

This section has three main parts. The first explains the system of land-capability grouping used by the Soil Conservation Service and indicates how use and management can be planned in terms of the units of this grouping. The second provides a table summarizing cropping systems and supplementary practices for the groups of soils and a table giving estimated average acre yields on each soil under two levels of management. The third discusses principles of management basic to good farming anywhere.

Land Capability Groupings

Capability grouping is a system of classification used to show the relative suitability of soils for crops, grazing, forestry, and wildlife. It is a practical grouping based on the needs of the soils and their responses to management. There are three levels in the grouping—unit, subclass, and class. Following are definitions for the land classes, subclasses, and units in Fillmore County.

Class I.—Deep, well drained and moderately well drained, nearly level productive soils. Suitable for intensive cultivation over long periods without special practices other than those generally used for good farming.
  I–1: Deep, light-colored to dark-colored silt loam and loam.
Class II.—Soils suited to tilled crops, pasture, and trees but with moderate limitations when tilled.
  Subclass IIe: Soils subject to moderate erosion:
    Unit:
      IIe–1: Dark to moderately dark, moderately well drained sloping soils.
      IIe–2: Light-colored, well-drained, gently sloping soils.

IIe–3: Moderately dark to dark, nearly level to gently sloping, somewhat excessively drained soils.

Subclass IIw: Soils moderately limited by excess water:

Unit:

IIw–1: Light-colored to moderately dark, nearly level to gently sloping soils.

IIw–2: Very dark imperfectly drained to poorly drained soils.

IIw–3: Dark well-drained soils subject to occasional overflow.

Class III.—Soils suited to tilled crops, pasture, or trees. Areas are good for wildlife.

Subclass IIIe: Gently sloping to sloping soils where erosion is the most outstanding source of risk to sustained use under cultivation:

Unit:

IIIe–1: Deep, light-colored to dark soils.

IIIe–2: Shallow soils.

Subclass IIIs: Nearly level to gently sloping, droughty soils:

Unit:

IIIs–1: Light-colored to dark-colored soils.

Subclass IIIw: Soils limited by excess water:

Unit:

IIIw–1: Very dark, moderately permeable soils.

IIIw–2: Dark, nearly level to gently sloping, slowly permeable soils.

IIIw–3: Alluvial land subject to overflow.

IIIw–4: Very poorly drained organic soils.

IIIw–5: Moderately dark, gently sloping, slowly permeable soils.

Class IV.—Soils suited to pasture, trees, but severely limited if used for tilled crops. Areas good for wildlife. Soils can be cultivated with special precautions.

Subclass IVe: Soils subject to severe erosion:

Unit:

IVe–1: Light-colored to dark soils, moderately steep to steep.

IVe–2: Shallow to moderately deep gently sloping to sloping soils.

Subclass IVs: Soils with severely limited capacity to hold moisture:

Unit:

IVs–1: Dark-colored, sloping to moderately steep soils.

IVs–2: Light-colored, gently sloping soils.

IVs–3: Light-colored, sloping soils.

Class VI.—Soils ordinarily not suitable for cultivation because of steep slopes, excess water, or other limitations, but suitable for pasture or woodland. Areas are good for wildlife.

Subclass VIe: Moderately steep to steep soils:

Unit:

VIe–1: Shallow to deep soils.

Subclass VIw: Soils limited by excess water:

Unit:

VIw–1: Mixed alluvial soils.

Class VII.—Soils not suitable for cultivation and severely limited for pasture or woodland. Areas are suited to wildlife.

Subclass VIIe: Moderately steep and steep soils:

Unit:

VIIe–1: Shallow soils.

Subclass VIIs: Moderately steep to steep soils:

Unit:

VIIs–1: Loose sandy soils and rock escarpments.

As shown in the foregoing list, the capability unit, sometimes called a management group, is the first level of grouping. A capability unit is made up of soils similar in management needs, in risk of damage, and in general suitability for use.

The next broader grouping, the subclass, is used to indicate the dominant kind of limitation. The letter symbol "e" indicates that the main limiting factor is hazard of erosion if plant cover is not maintained; "w" means excess water either in or on the soil; and "s" shows that the soils are shallow, droughty, or unusually low in fertility.

The broadest grouping, the land class, is identified by Roman numerals. There are eight land classes, but only seven of them are represented in Fillmore County. All the soils in one land class have limitations and management problems in about the same degree, although of different kinds as shown by the subclass. All the land classes except class I may contain one or more subclasses. Usually there is no need to divide class I into subclasses, for it contains the soils that have no serious limitations.

Management by Capability Units

Soils in one capability unit have about the same limitations and similar risks of damage. The soils in one unit therefore need about the same kind of management, though they may have formed from different kinds of parent material in different ways.

The soils of Fillmore County have been placed in 25 capability units. These units are described in the following pages; the soils in each unit are listed, suitable crops are given, and desirable management is suggested.

To avoid repeating, for each unit, practices that apply to all land used for crops, pasture, trees, or wildlife, those practices are summarized as follows:

Cropland.—On soils used for tilled crops apply lime and fertilizer according to needs shown by soil tests and field trials. Apply crop residues and manures to supply fresh organic matter and to improve soil tilth.

To dispose of excess water, build new waterways or reshape old ones where necessary; reseed and maintain to keep them working well.

Seed headlands (areas to turn machinery at the edges of fields) and keep them in grass. Delay mowing of these areas until after time to harvest small grains —otherwise ground-nesting birds will lose their young.

Pastureland.—Seed and maintain stands of good varieties of grasses and legumes. Old pastures can be made more productive by breaking (usually disking), fertilizing, and seeding to grass mixtures that will provide grazing a greater part of the season. Control grazing to maintain a good cover and to prevent damage by trampling. Clip weeds while in the bloom stage. Apply lime and fertilizer where soil tests indicate they will get good response.

Woodland.—Improve stands by removing deformed or diseased trees and those undesirable for timber. Harvest trees when mature. Plant openings in woodlands to desirable kinds of trees. Maintain shrub or shrub-conifer borders around woods. Protect woods from fire and grazing.

Wildlife habitats.—Plant, in suitable places, to furnish cover and food for wildlife, evergreens, shrubs, grasses, legumes, or aquatic plants and protect them from fire and overgrazing. Keep livestock away from streambanks. Plant willows or build structures required to control bank cutting. Seed ditchbanks to grasses or legumes, and delay mowing or grazing until after time to harvest grains. Up-to-date information on management of wildlife areas can be obtained from your county agent or the local representative of the Soil Conservation Service.

The benefits to be obtained by practicing management of the kind suggested in this report can be measured by referring to tables 3 and 4. The first table summarizes systems of cropping and supplementary practices for each of the capability units. The second table lists average acre yields to be expected from each soil under two levels of management, that prevailing in the county at the time of survey, and improved management.

Capability unit I–1 consists of deep, productive, light-colored to dark, friable silty or loamy soils. The soils have been formed from glacial till, wind-laid silts, or outwash materials on nearly level topography. They are easy to work and at least fairly fertile. They are moderately well drained and have a high moisture-supplying capacity. They are permeable to roots to depths of several feet. The soils of this unit are:

Fayette silt loam, 0 to 1 percent slopes (Fa).
Kenyon silt loam, 0 to 1 percent slopes (Kd).
Racine and Ostrander silt loams and loams, 0 to 1 percent slopes (Ra).
Renova silt loam and loam, 0 to 1 percent slopes (Rf).
Tama and Downs silt loams, 0 to 1 percent slopes (Ta).
Waukegan silt loam, 0 to 1 percent slopes (Wa).

These soils are well suited to corn, small grains, alfalfa, red and alsike clovers, bromegrass, timothy, or trees. For best yields of crops and pasture, apply lime and fertilizer according to needs indicated by soil tests and field trials.

Capability unit IIe–1 consists of deep productive, moderately dark to dark soils. Except that they are gently sloping and erodible, the soils resemble those of capability unit I. The soils in this unit are:

Kasson silt loam, 0 to 1 percent slopes (Ka).
Kasson silt loam, 2 to 6 percent slopes (Kb).
Kenyon silt loam, 2 to 6 percent slopes (Ke).
Lindstrom silt loam and fine sandy loam, 2 to 6 percent slopes (La).
Racine and Ostrander silt loams and loams, 2 to 6 percent slopes (Rb).
Racine and Ostrander silt loams and loams, eroded, 2 to 6 percent slopes (Rc).
Tama and Downs silt loams, 2 to 6 percent slopes (Tb).
Tama and Downs silt loams, eroded, 2 to 6 percent slopes (Tc).
Waukegan silt loam, 2 to 6 percent slopes (Wb).

These soils are well suited to corn, soybeans, oats, barley, alfalfa, red, alsike, and Ladino clovers, bromegrass, timothy, or trees. If tilled crops are grown, use contouring, stripcropping, terracing, and grassed waterways, as needed, to control erosion. For best yields of crops or pasture, apply lime and fertilizer in amounts indicated by soil tests and field trials.

Capability unit IIe–2 consists of deep, light-colored soils that are at least moderately productive. Except that they are gently sloping and subject to erosion, the soils resemble those of capability unit I–1. The soils are:

Fayette silt loam, 2 to 6 percent slopes (Fb).
Fayette silt loam, eroded, 2 to 6 percent slopes (Fc).
Fayette silt loam, terrace, 2 to 6 percent slopes (Fk).
Fayette silt loam, terrace, eroded, 2 to 6 percent slopes (Fl).
Renova silt loam and loam, 2 to 6 percent slopes (Rg).
Renova silt loam and loam, eroded, 2 to 6 percent slopes (Rh).
Seaton and Port Byron silt loams, eroded, 2 to 6 percent slopes (Sd).

These soils are well suited to corn, soybeans, small grains, afalfa, alsike, red, and Ladino clovers, bromegrass, timothy, or trees. If tilled crops are grown, use contouring, stripcropping, terracing, and grassed waterways, as needed, to control erosion. For best yields of crops or pasture, apply lime and fertilizer in amounts indicated by soil tests and field trials.

Capability unit IIe–3 consists of moderately productive soils that have formed from loamy glacial till or outwash material and occur on nearly level to gently sloping topography. These soils are moderately dark to dark, friable, and loamy. They are easy to work and are fertile. They are somewhat excessively drained and have only a moderate moisture-supplying capacity. They are permeable to roots to depths of several feet. The soils of this unit are:

Dakota loam, 0 to 1 percent slopes (De).
Dakota loam, 2 to 6 percent slopes (Df).
Dickinson loam, 2 to 6 percent slopes (Do).
Dickinson loam, eroded, 2 to 6 percent slopes (Dp).
Thurston and Wykoff loams, moderately deep, 0 to 1 percent slopes (Tl).
Thurston and Wykoff loams, moderately deep, eroded, 2 to 6 percent slopes (Tm).

These soils are well suited to corn, soybeans, oats, barley, alfalfa, alsike, red and Ladino clovers, bromegrass, timothy, or trees. When tilled crops are grown, use contouring, stripcropping, terracing, cover crops, and grassed waterways, as needed, to control wind or water erosion. For best yields of crops or pasture, apply lime and fertilizer in amounts indicated by soil tests and field trials.

Capability unit IIw–1 consists of deep productive soils formed from alluvial and colluvial materials. The soils occur on nearly level and gently sloping relief along waterways and alluvial fans. They are fertile and easy to work. The soils have a high moisture-supplying capacity and are permeable to roots to a depth of several feet. This capability unit is made up of two mapping units, in each of which there is a light-colored soil and a dark-colored soil.

Chaseburg and Judson silt loams, 0 to 1 percent slopes (Ca).
Chaseburg and Judson silt loams, 2 to 6 percent slopes (Cb).

These soils are well suited to corn, soybeans, oats, barley, alsike, red and Ladino clovers, bromegrass, timothy, or trees. If tilled crops are grown, use grassed waterways, diversion terraces, or other practices to dispose of excess water. For best yields of crops or pastures, apply lime and fertilizer in amounts indicated by soil tests and field trials.

Capability unit IIw–2 consists of deep productive soils formed from glacial till and outwash material. The soils occur on nearly level upland depressions or along streams. They are very dark, friable, moderately heavy textured soils. Although somewhat slow to dry out, they are warm enough for cultivation in the spring, and they are at least moderately easy to work. They are highly fertile and have a high moisture-supplying capacity. The soils are:

Floyd and Clyde silty clay loams, overwash, 0 to 3 percent slopes (Fn).
Kato silty clay loam (Kc).

Without supplementary drainage, these soils are well suited to alsike and Ladino clovers, reed canarygrass and bluegrass. They are also well suited to corn, oats, and soybeans, if tile drains or open ditch drains and dikes are used, as needed, to dispose of excess water. For best yields of crops or pastures, apply lime and fertilizer in amounts indicated by soil tests and field trials.

Capability unit IIw–3 consists of several deep productive soils mapped together as Alluvial land, medium textured, well drained (Ab). These soils were derived from alluvium and are on nearly level flood plains. They are silty to loamy in the surface layers and have silty to gravelly materials in the lower layers. They are fertile soils and are easy to work. They have a high moisture-supplying capacity.

Except for some small or inaccessible areas, these soils are well suited to bromegrass, timothy, alsike, red, and Ladino clovers, or trees. No special practices are needed. Corn, soybeans, and oats also can be grown on these soils, but flooding will occasionally cause the loss of a crop. Protect streambanks from cutting and flooding. Lime and fertilizer are needed for cultivated crops on some of these soils. Apply lime and fertilizer in amounts indicated by soil tests and field trials.

Capability unit IIIe–1 consists of deep, well-drained, moderately dark to dark, moderately to highly productive soils. The soils have formed from glacial till, wind-laid silts, or bedrock residuum. They are gently rolling or rolling. They are friable silty or loamy soils that are easy to work. They have a moderate to high moisture-supplying capacity and are permeable to roots to depths of several feet. In some of these soils, the original high fertility and high moisture-supplying capacity have been reduced through erosion. The soils are:

Fayette silt loam, eroded, 7 to 11 percent slopes (Fd).
Fayette silt loam, terrace, eroded, 7 to 17 percent slopes (Fm).
Lindstrom silt loam and fine sandy loam, 7 to 11 percent slopes (Lb).
Racine and Ostrander silt loams and loams, eroded, 7 to 11 percent slopes (Rd).
Renova silt loam and loam, eroded, 7 to 11 percent slopes (Rk).
Seaton and Port Byron silt loams, eroded, 7 to 11 percent slopes (Se).
Tama and Downs silt loams, 7 to 11 percent slopes (Td).
Tama and Downs silt loams, eroded, 7 to 11 percent slopes (Te).

These soils are well suited to corn, oats, barley, alfalfa, bromegrass, timothy, alsike, red, and Ladino clovers, or trees. If cultivated crops are grown, use contouring, stripcropping, terracing, or grassed waterways, as needed, to control erosion. For best yields of crops or pastures, apply lime and fertilizer in amounts indicated by soil tests and field trials.

Capability unit IIIe–2 consists of shallow, moderately productive soils. The soils have formed on gentle slopes from wind-laid silts or glacial till. They are friable and easy to work. They are permeable to roots down to bedrock, which is at depths of 1 to 2 feet. Because of shallowness, most of these soils are moderately low in fertility and in moisture-holding capacity. The soils are:

Dubuque and Whalan silt loams, shallow, 2 to 6 percent slopes (Ds).
Dubuque and Whalan silt loams, shallow, eroded, 2 to 6 percent slopes (Dt).
Rockton and Dodgeville silt loams, shallow, 2 to 6 percent slopes (Rm).
Rockton and Dodgeville silt loams, shallow, eroded, 2 to 6 percent slopes (Rn).

The soils are well suited to corn, oats, barley, alfalfa, bromegrass, timothy, red, alsike, and Ladino clovers, or trees. If tilled crops are grown, use contouring, stripcropping, and grassed waterways to control erosion. Most of these soils are too shallow to allow use of terraces. For good yields of crops and pastures, apply lime and fertilizer in amounts indicated by soil tests and field trials.

Capability unit IIIs–1 consists of shallow to moderately deep soils formed from wind-laid material, sandy glacial till, or outwash. They are nearly level or gently sloping. They have dark, friable, surface layers of fine sandy loam and generally are underlain by coarse sandy or gravelly materials at depths of 18 to 42 inches. They are easy to work. Though they are permeable to roots to considerable depths, they are only moderately fertile and have a low moisture-holding capacity. In dry periods they are subject to wind erosion. The soils are:

Dakota fine sandy loam, shallow, 0 to 1 percent slopes (Da).
Dakota fine sandy loam, shallow, 2 to 6 percent slopes (Db).
Dakota fine sandy loam, eroded, shallow, 2 to 6 percent slopes (Dc).
Dickinson fine sandy loam, 0 to 6 percent slopes (Dg).
Dickinson fine sandy loam, eroded, 2 to 6 percent slopes (Dh).
Dickinson fine sandy loam, moderately deep, 2 to 6 percent slopes (Dl).
Dickinson fine sandy loam, moderately deep, eroded, 2 to 6 percent slopes (Dm).
Meridian fine sandy loam, 0 to 1 percent slopes (Mb).
Meridian fine sandy loam, slightly or moderately eroded, 2 to 6 percent slopes (Mc).
Thurston and Wykoff sandy loams, shallow, 0 to 1 percent slopes (To).
Thurston and Wykoff sandy loams, shallow, eroded, 2 to 6 percent slopes (Tp).

Most of these soils are well suited to peas for canning, oats, barley, alfalfa, bromegrass, timothy, or trees. They are only moderately well suited to corn for grain or to other crops that need large amounts of moisture. Alfalfa and red clover cannot be grown for more than a few years on some of the soils, unless a topdressing of phosphate and barnyard manure is applied or other special measures to improve fertility are taken.

Capability unit IIIw–1 consists of deep, very dark, poorly to very poorly drained productive soils. They occur on upland draws, in depressions, and on outwash plains. The soils are moderately fine textured, moderately friable, and fairly easy to work. They are high in fertility and have a very high moisture-supplying capacity. Because of their position, some of them are flooded occasionally, and all have a water table that is high at least some of the year. The soils are:

Clyde silty clay loam (Cg).
Clyde silty clay loam, overwash (Ch).
Marshan silty clay loam (Ma).

Without supplemental drainage, these soils are well suited only to reed canarygrass, alsike clover, and some other wet-site grasses and legumes that can be used for hay and pasture. If drained, these soils are well suited to corn, soybeans, oats, alsike, red, and Ladino clovers, bromegrass, and timothy. Tile drains need suitable outlets. If these soils are used for crops or pastures, apply lime and fertilizer in amounts indicated by soil tests and field trials.

Capability unit IIIw–2 contains one soil, Skyberg silt loam, 0 to 3 percent slopes (Sg). This is a dark soil of moderate depth and productivity that has formed from firm glacial till. It is silty, moderately fertile, and easy to work. It is poorly drained and slowly permeable, and most crop roots penetrate no more than 18 inches. The soil is slow to dry out and to warm up enough for tillage and planting in spring.

Without supplementary drainage, this soil is fairly well suited to corn, soybeans, oats, alsike, red, and Ladino clovers, bromegrass, and timothy. Yields can be improved considerably by providing supplementary drainage and adequate fertilizers. Apply lime and fertilizer as indicated by soil tests and field trials.

Capability unit IIIw–3 consists of deep soils derived from alluvium. They occur on nearly level flood plains. Productivity is only moderate, because crops are occasionally lost or damaged by flooding. One of the soils is sandy or gravelly and has a low moisture-supplying capacity. The other is moderately fine textured and slow to drain. Both are friable, easy to work, and moderately to highly fertile. Both are permeable to roots to depths of several feet. The soils are in two mapping units:

Alluvial land, medium textured, poorly drained (Aa).
Alluvial land, coarse textured, well drained (Ac).

Without protection from overflow, timothy, bromegrass, alfalfa, and red clover produce good fields of hay or pasture on the coarse textured soil. Corn grows well except in times of drought or flood. The medium-textured soil, if not protected from overflow or not improved by artificial drainage, is well suited to alsike or Ladino clover, reed canarygrass, timothy, and bromegrass. These plants will provide hay and pasture. For best yields, protect these soils from flooding. The wet soil needs to be drained. If these measures are taken, the soils are well suited to corn, oats, soybeans, alfalfa, red and Ladino clovers, bromegrass, and timothy. Control streambank erosion by plantings or by engineering measures.

Capability unit IIIw–4 consists of deep organic soils mapped together as Peat and muck (Pc). The soils are very poorly drained and occupy small areas in depressions, old stream channels, and seeps. The peat consists of brown slightly decomposed sedges, reeds, and grasses. The decay took place under the influence of a high water table. The muck is more decomposed than peat; it is darker than the peat and is mixed with considerable mineral matter.

These soils are suited only to wildlife unless drained. If adequately drained by tile drains or open ditches, and adequately fertilized with potash and phosphate, these soils are well suited to corn and vegetables. If planted to row crops for several years, seed the soils to alsike or Ladino clovers, reed canarygrass, timothy, or other pasture or hay crops.

Capability unit IIIw–5 consists of dark slowly permeable soils mapped together as Schapville silt loam and silty clay loam, 2 to 6 percent slopes (Sa). They have formed on thin loess deposits that overlie shale or limestone residuum. They are somewhat poorly drained to moderately well drained.

These soils are suited to general farm crops, including hay and pasture. Use ditches to divert water.

Capability unit IVe–1 consists of moderately deep to deep, well-drained to excessively drained soils. These soils are moderately dark to dark and moderately productive. They have formed from wind-laid silts and glacial till and occur on rolling uplands and valley slopes. They are on stronger slopes and are more erodible than the soils of IIIe–1. In most respects, the soils of IVe–1 resemble those of IIIe–1. Erosion has caused the loss of their original high fertility and high moisture-supplying capacity. The soils are:

Dickinson loam, eroded, 7 to 11 percent slopes (Dr).
Fayette silt loam, severely eroded, 7 to 11 percent slopes (Fe).
Fayette silt loam, eroded, 12 to 17 percent slopes (Ff).
Lindstrom silt loam and fine sandy loam, slightly or moderately eroded, 12 to 17 percent slopes (Lc).
Racine and Ostrander silt loams and loams, eroded, 12 to 17 percent slopes (Re).
Renova silt loam and loam, eroded, 12 to 17 percent slopes (Rl).
Seaton and Port Byron silt loams, eroded, 12 to 17 percent slopes (Sf).
Tama and Downs silt loams, 12 to 17 percent slopes (Tf).
Tama and Downs silt loams, eroded, 12 to 17 percent slopes (Tg).
Thurston and Wykoff loams, moderately deep, eroded, 7 to 17 percent slopes (Tn).

These soils are well suited to alfalfa, birdsfoot trefoil, red clover, bromegrass, timothy, and trees. The areas can be used for wildlife. The soils are too erodible for frequent cultivation. Corn, oats, and barley can be grown occasionally, but stripcropping, grassed waterways, or other practices will be needed to control erosion. If the soils are used for row crops or pasture, apply lime and fertilizer in amounts indicated by soil tests and field trials.

Capability unit IVe–2 consists of light- and dark-colored, silty, friable, shallow soils of the uplands. These soils are nearly level to sloping. Some are eroded. Their productivity is moderately low. All are underlain by bedrock at depths of 6 to 18 inches. Except where very shallow or very steep, they are easy to work. Although naturally fertile, their shallowness and generally low capacity for holding moisture seriously limit their productivity. The soils are:

Dubuque and Whalan silt loams, shallow, eroded, 7 to 11 percent slopes (Du).
Rockton and Dodgeville silt loams, shallow, eroded, 7 to 11 percent slopes (Ro).
Schapville silt loam and silty clay loam, 7 to 11 percent slopes (Sb).
Sogn silt loam, 0 to 6 percent slopes (Sh).

These soils are well suited to timothy, bromegrass, or trees. Some areas are favorable to wildlife. Alfalfa, birdsfoot trefoil, and red clover will grow but may be killed in dry periods. They will need to be reseeded frequently. The soils are too erodible for frequent cultivation. Corn, oats, and barley can be grown occasionally, if contouring, stripcropping, or other practices are used, as needed, to control erosion. The soils are too shallow for terracing. If they are used for cultivated crops or pasture, apply lime and fertilizer in amounts indicated by soil tests and field trials.

Capability unit IVs–1 consists of shallow and moderately deep, gently sloping to sloping, moderately productive, sandy soils. They have formed on glacial till, outwash, and stream-terrace materials. They are friable, easy to work, and moderately fertile. All the soils are erodible. They have a low moisture-holding capacity. The soils are:

- Dickinson fine sandy loam, eroded, 7 to 11 percent slopes (Dk).
- Dickinson fine sandy loam, moderately deep, eroded, 7 to 11 percent slopes (Dn).
- Hixton fine sandy loam, slightly or moderately eroded, 2 to 11 percent slopes (Ha).
- Thurston and Wykoff sandy loams, shallow, eroded, 7 to 11 percent slopes (Tr).

These soils are well suited to timothy, bromegrass, or trees. Areas of these soils are favorable to wildlife. Alfalfa, birdsfoot trefoil, and red clover will grow, but they will need to be reseeded frequently because they may be killed in dry periods. The soils are too erodible for frequent cultivation. Corn, oats, and barley can be grown occasionally if contouring, stripcropping, terracing, or other erosion control practices are used. If cultivated or pastured, apply lime and fertilizer in amounts indicated by soil tests and field trials.

Capability unit IVs–2 consists of light-colored soils on gently sloping to sloping relief. They have formed chiefly on valley slopes, stream terraces, outwash plains, and below sandstone outcrops. They are low in productivity, fertility, and moisture-supplying capacity. When dry, they are subject to wind erosion. The soils are:

- Chelsea and Boone loamy fine sands, 2 to 6 percent slopes (Cc).
- Plainfield and Sparta loamy fine sands, slightly or moderately eroded, 2 to 6 percent slopes (Pa).

These soils are well suited to timothy, bromegrass, or trees. They are favorable sites for wildlife. Alfalfa, birdsfoot trefoil, and red clover will grow, but good stands are difficult to maintain unless the soils are top-dressed with manure and phosphorus. Frequent reseeding will be needed. The soils are too erodible for frequent cultivation. Corn and small grains can be grown occasionally, if contouring and stripcropping are used, as needed, to control erosion. If these soils are cultivated or pastured, apply lime and fertilizer in amounts indicated by soil tests and field trials.

Capability unit IVs–3 consists of light-colored sloping soils of low productivity. Except for being eroded and more sloping, the soils resemble those of capability unit IVs–2. The soils are:

- Chelsea and Boone loamy fine sands, slightly or moderately eroded, 7 to 11 percent slopes (Cd).
- Plainfield and Sparta loamy fine sands, eroded, 7 to 11 percent slopes (Pb).

These soils are well suited to timothy, bromegrass, or trees. They are favorable sites for wildlife. Alfalfa, birdsfoot trefoil, and red clover will grow, but good stands are difficult to maintain unless the soils are top-dressed with manure and phosphate. The pastures will need to be reseeded frequently.

The soils are too erodible for frequent cultivation. Corn and small grains can be grown occasionally, if erosion is carefully controlled. If stripcropping is practiced, row crops can be grown occasionally. If these soils are cultivated or pastured, apply lime and fertilizer according to needs shown by soil tests and field trials.

Capability unit VIe–1 consists of soils that are steep or shallow to bedrock. Some are severely eroded and, if left bare, all are very erodible. The soils are:

- Dubuque and Whalan silt loams, shallow, slightly or moderately eroded, 12 to 17 percent slopes (Dv).
- Fayette silt loam, severely eroded, 12 to 17 percent slopes (Fg).
- Rockton and Dodgeville silt loams, shallow, eroded, 12 to 17 percent slopes (Rp).
- Schapville silt loam and silty clay loam, slightly or moderately eroded, 12 to 17 percent slopes (Sc).
- Sogn silt loam, eroded, 7 to 11 percent slopes (Sk).
- Tama and Downs silt loams, severely eroded, 12 to 17 percent slopes (Th).
- Tama and Downs silt loams, 18 to 35 percent slopes (Tk).

These soils are poorly suited to row crops. They are well suited to bromegrass, timothy, birdsfoot trefoil, or trees. The Fayette soils and the Tama and Downs soils are also well suited to alfalfa and red clover. All the soils of the unit will produce food and cover favorable for wildlife. If they are cultivated frequently, erosion cannot be controlled on most of these soils, because they are too steep. The soils will withstand the occasional shallow tillage necessary for seeding permanent hay and pasture. If hay or pasture is grown, apply lime and fertilizer in amounts indicated by soil tests and field trials.

Capability unit VIw–1 consists of a miscellaneous land type, Mixed alluvial land, 0 to 6 percent slopes (Md). The land type is variable in texture, drainage, permeability, and fertility. Many areas are covered with stones, are cut by stream channels, and are inaccessible to farm machinery.

Most of the areas are suitable only for pasture or trees, and these are favorable sites for wildlife. A few of the less sloping areas are accessible, tillable, and not subject to frequent flooding. On these areas corn and other row crops can be grown.

Capability unit VIIe–1 consists of moderately steep to steep soils of the uplands and steep rocky land. The soils and land types are:

- Dubuque and Whalan silt loams, shallow, severely eroded, 12 to 17 percent slopes (Dw).
- Dubuque and Whalan silt loams, shallow, 18 to 45 percent slopes (Dx).
- Fayette silt loam, slightly or moderately eroded, 18 to 45 percent slopes (Fh).
- Lindstrom silt loam and fine sandy loam, 18 to 45 percent slopes (Ld).
- Rockton and Dodgeville silt loams, shallow, 18 to 35 percent slopes (Rr).
- Steep rocky land (Sl).

These soils and land types are too shallow or too eroded for cultivation. Some will produce alfalfa, birdsfoot trefoil, bromegrass, timothy, or trees, or areas can be used for wildlife. If used for pasture or as woodlots, the soils must be carefully managed to control erosion.

Capability unit VIIs–1 consists of moderately steep to steep sandy soils and steep escarpments. The soils

TABLE 3.—*Soils of Fillmore County arranged by capability units, and suggested cropping systems and practices for control of erosion and water*

[These cropping systems and practices apply under the management common in 1956; most crop residues are removed, and lime and fertilizer are applied in accordance with soil tests]

SUITABLE FOR CULTIVATION

Capability unit and soils	Fertility management	Most intensive suitable cropping system	Practices for control of erosion and water
I-1 Fayette silt loam, 0 to 1 percent slopes. Kenyon silt loam, 0 to 1 percent slopes. Racine and Ostrander silt loams and loams, 0 to 1 percent slopes. Renova silt loam and loam, 0 to 1 percent slopes. Tama and Downs silt loams, 0 to 1 percent slopes. Waukegan silt loam, 0 to 1 percent slopes.	Moderate requirement for lime, potassium, and phosphorus. Phosphate and potash on grain. Manure and starter fertilizer on row crops. Nitrogen on 2nd year row crop.	Row crop for 2 years, grain, and hay.	None.
IIe-1 Kasson silt loam, 0 to 1 percent slopes. Kasson silt loam, 2 to 6 percent slopes. Kenyon silt loam, 2 to 6 percent slopes. Lindstrom silt loam and fine sandy loam, 2 to 6 percent slopes. Racine and Ostrander silt loams and loams, 2 to 6 percent slopes. Racine and Ostrander silt loams and loams, eroded, 2 to 6 percent slopes. Tama and Downs silt loams, 2 to 6 percent slopes. Tama and Downs silt loams, eroded, 2 to 6 percent slopes. Waukegan silt loam, 2 to 6 percent slopes.	Moderate requirement for lime, potassium, and phosphorus. Phosphate and potash on grain. Manure and starter fertilizer on row crops. Nitrogen on 2nd year row crop.	Row crop for 2 years, grain, and hay for 2 years. Row crop for 2 years, grain, and hay. Row crop, grain, and hay for 2 years. Row crop for 2 years, grain, and hay.	None. Contouring.[1] Stripcropping. Terracing.
IIe-2 Fayette silt loam, 2 to 6 percent slopes. Fayette silt loam, eroded, 2 to 6 percent slopes. Fayette silt loam, terrace, 2 to 6 percent slopes. Fayette silt loam, terrace, eroded, 2 to 6 percent slopes. Renova silt loam and loam, 2 to 6 percent slopes. Renova silt loam and loam, eroded, 2 to 6 slopes. Seaton and Port Byron silt loams, eroded, 2 to 6 percent slopes.	Return all crop residues. Moderate requirement for lime, potassium, and phosphorus. Phosphate and potash on grain. Manure and starter fertilizer on row crops. Nitrogen on 2nd year row crop.	Row crop, grain, and hay for 2 years. Row crop, grain, and hay. Row crop, grain, and hay for 2 years. Row crop for 2 years, grain, and hay.	None. Contouring. Stripcropping. Terracing.
IIe-3 Dakota loam, 0 to 1 percent slopes. Dakota loam, 2 to 6 percent slopes. Dickinson loam, 2 to 6 percent slopes. Dickinson loam, eroded, 2 to 6 percent slopes. Thurston and Wykoff loams, moderately deep, 0 to 1 percent slopes. Thurston and Wykoff loams, moderately deep, eroded, 2 to 6 percent slopes.	Return all crop residues. High requirement for nitrogen. Moderate requirement for potassium and phosphorus. Manure and starter fertilizer on row crops. Lime where needed.	Row crop for 2 years, grain, and hay. Row crop, grain, and hay for 2 years. Row crop for 2 years, grain, and hay for 2 years. Row crop, grain, and hay for 2 years. Row crop for 2 years, grain, and hay.	None. None. Contouring. Stripcropping. Terracing.
IIw-1 Chaseburg and Judson silt loams, 0 to 1 percent slopes. Chaseburg and Judson silt loams, 2 to 6 percent slopes.	Moderate requirement for lime, potassium, and phosphorus. Generally managed with adjacent Fayette and Tama soils.	Row crop for 2 years, grain, and hay.[2]	Grassed waterways and diversion terraces.
IIw-2 Floyd and Clyde silty clay loams, overwash, 0 to 3 percent slopes. Kato silt clay loam.	Moderate requirement for potassium and phosphorus. Use deep-rooted legumes to improve physical condition.	Row crop for 2 years, grain, and hay.[2]	Tile or open ditch drainage.
IIw-3 Alluvial land, medium textured, well drained.	Moderate requirement for potassium and phosphorus.	Principally row crops with an occasional meadow.	Streambank protection and diking where feasible.

See footnotes at end of table.

TABLE 3.—*Soils of Fillmore County arranged by capability units, and suggested cropping systems and practices for control of erosion and water*—Continued

Capability unit and soils	Fertility management	Most intensive suitable cropping system	Practices for control of erosion and water
IIIe–1 Fayette silt loam, eroded, 7 to 11 percent slopes. Fayette silt loam, terrace, eroded, 7 to 17 percent slopes. Lindstrom silt loam and fine sandy loam, 7 to 11 percent slopes. Racine and Ostrander silt loams and loams, eroded, 7 to 11 percent slopes. Renova silt loam and loam, eroded, 7 to 11 percent slopes. Seaton and Port Byron silt loams, eroded, 7 to 11 percent slopes. Tama and Downs silt loams, 7 to 11 percent slopes. Tama and Downs silt loams, eroded, 7 to 11 percent slopes.	Moderate requirement for lime, potassium, and phosphorus. Topdress 2nd year hay with potash and phosphate. Manure and starter fertilizer on row crops and potash and phosphate at time of seeding legumes. Starter fertilizer or manure, as well as sidedressing with nitrogen, 2nd year corn.	Grain, and hay for 3 years. Row crop, grain, and hay for 3 years. Row crop, grain, and hay for 2 years. Row crop for 2 years, grain, and hay for 2 years.	None. Contouring. Stripcropping. Terracing.
IIIe–2 Dubuque and Whalan silt loams, shallow, 2 to 6 percent slopes. Dubuque and Whalan silt loams, shallow, eroded, 2 to 6 percent slopes. Rockton and Dodgeville silt loams, shallow, 2 to 6 percent slopes. Rockton and Dodgeville silt loams, shallow, eroded, 2 to 6 percent slopes.	Return all crop residues. Moderate to high requirement for lime, phosphorus, and potassium. Phosphate and potash at time of seeding legumes. Manure and starter fertilizer on row crops. Topdress hay every 2 years with phosphate and potash.	Row crop, grain, and hay for 3 years. Row crop, grain, and hay for 2 years. Row crop for 2 years, grain, and hay for 3 years.	None. Contouring. Stripcropping.
IIIs–1 Dakota fine sandy loam, shallow, 0 to 1 percent slopes. Dakota fine sandy loam, shallow, 2 to 6 percent slopes. Dakota fine sandy loam, eroded, shallow, 2 to 6 percent slopes. Dickinson fine sandy loam, 0 to 6 percent slopes. Dickinson fine sandy loam, eroded, 2 to 6 percent slopes. Dickinson fine sandy loam, moderately deep, 2 to 6 percent slopes. Dickinson fine sandy loam, moderately deep, eroded, 2 to 6 percent slopes. Meridian fine sandy loam, 0 to 1 percent slopes. Meridian fine sandy loam, slightly or moderately eroded, 2 to 6 percent slopes. Thurston and Wykoff sandy loams, shallow, 0 to 1 percent slopes. Thurston and Wykoff sandy loams, shallow, eroded, 2 to 6 percent slopes.	Return all crop residues. Moderate to high requirement for lime, phosphorus, and potassium. Phosphate and potash at time of seeding legumes. Manure and starter fertilizer on row crops. Topdress hay every 2 years with phosphate and potash.	Row crop, sweetclover, row crop, grain, and hay for 2 years. Row crop, grain, and hay for 2 years.	Wind stripcropping 0 to 1 percent slopes. Contour stripcropping.
IIIw–1 Clyde silty clay loam. Clyde silty clay loam, overwash. Marshan silty clay loam.	Moderate requirement for potassium and phosphorus. Use deep-rooted legumes to improve physical condition.	Row crop for 2 years, grain, and hay.[2]	Tile and open ditch drains.
IIIw–2 Skyberg silt loam, 0 to 3 percent slopes.	High potassium and lime requirement. Moderate phosphorus requirement. Use deep-rooted legumes to improve physical condition.	Row crop, grain, and hay.	Surface drainage for level areas.
IIIw–3 Alluvial land, medium textured, poorly drained. Alluvial land, coarse textured, well drained.	Moderate requirement for potassium and phosphorus.	Row crops, and an occasional meadow.	Streambank protection and diking where feasible.
IIIw–4 Peat and muck.	High requirement for potassium and phosphorus.	Row crops and vegetables with an occasional meadow.	Tile and open ditch drains.

See footnotes at end of table.

TABLE 3.—*Soils of Fillmore County arranged by capability units, and suggested cropping systems and practices for control of erosion and water*—Continued

Capability unit and soils	Fertility management	Most intensive suitable cropping system	Practices for control of erosion and water
IIIw-5 Schapville silt loam and silty clay loam, 2 to 6 percent slopes.	Return all crop residues. Moderate to high requirement for lime, phosphorus, and potassium. Phosphate and potash at time of seeding legumes. Manure and starter fertilizer on row crops. Topdress hay every 2 years with phosphate and potash.	Row crop, grain, and hay for 2 years.	Diversion terraces and tile drains to intercept seepage water.
IVe-1 Dickinson loam, eroded, 7 to 11 percent slopes. Fayette silt loam, severely eroded, 7 to 11 percent slopes. Fayette silt loam, eroded, 12 to 17 percent slopes. Lindstrom silt loam and fine sandy loam, slightly or moderately eroded, 12 to 17 percent slopes. Racine and Ostrander silt loams and loams, eroded, 12 to 17 percent slopes. Renova silt loam and loam, eroded, 12 to 17 percent slopes. Seaton and Port Byron silt loams, eroded, 12 to 17 percent slopes. Tama and Downs silt loams, 12 to 17 percent slopes. Tama and Downs silt loams, eroded, 12 to 17 percent slopes. Thurston and Wykoff loams, moderately deep, eroded, 7 to 17 percent slopes.	Moderate requirement for lime, potassium, and phosphorus. Potash and phosphate at time of seeding legumes. Topdress hay every 2 years with potash and phosphate. Manure and starter fertilizer on row crops.	Grain, and hay for 3 years. Row crop, grain, and hay for 4 years.	None. Stripcropping. Grassed waterways needed for both systems of cropping.
IVe-2 Dubuque and Whalan silt loams, shallow, eroded, 7 to 11 percent slopes. Rockton and Dodgeville silt loams, shallow, eroded, 7 to 11 percent slopes. Schapville silt loam and silty clay loam, 7 to 11 percent slopes. Sogn silt loam, 0 to 6 percent slopes.	Return all crop residues. Moderate to high requirement for lime, phosphorus, and potassium. Phosphate and potash at time of seeding legumes. Manure and starter fertilizer on row crops. Topdress hay every 2 years with phosphate and potash.	Grain, and hay for 3 years. Row crop, grain, and hay for 4 years. Row crop, grain, and hay for 3 years.	None. Contouring. Stripcropping. Grassed waterways needed for all three systems of cropping.
IVs-1 Dickinson fine sandy loam, eroded, 7 to 11 percent slopes. Dickinson fine sandy loam, moderately deep, eroded, 7 to 11 percent slopes. Hixton fine sandy loam, slightly or moderately eroded, 2 to 11 percent slopes. Thurston and Wykoff sandy loams, shallow, eroded, 7 to 11 percent slopes.	Return all crop residues. High requirement for nitrogen. Moderate requirement for potassium and phosphorus. Manure and starter fertilizer on row crops. Lime where needed.	Grain, and hay for 2 years. Row crop, grain, and hay for 3 years. Row crop, grain, and hay for 2 years.	None. Contouring. Stripcropping.
IVs-2 Chelsea and Boone loamy fine sands, 2 to 6 percent slopes. Plainfield and Sparta loamy fine sands, slightly or moderately eroded, 2 to 6 percent slopes.	Return all crop residues. High requirement for nitrogen, potassium, and phosphorus. Manure and starter fertilizer on row crops. Topdress hay every 2 years. Sidedressing of nitrogen for corn.	Row crop, grain, and hay for 3 years. Row crop, grain, and hay for 2 years.	None. Stripcropping and field shelterbelts.
IVs-3 Chelsea and Boone loamy fine sands, slightly or moderately eroded, 7 to 11 percent slopes. Plainfield and Sparta loamy fine sands, eroded, 7 to 11 percent slopes.	Return all crop residues. High requirement for nitrogen, potassium, and phosphorus. Manure and starter fertilizer on crops. Topdress hay every 2 years. Sidedress corn with nitrogen.	Grain, and hay for 3 years. Row crop, grain, and hay for 3 years.	None. Stripcropping. Diversion terraces for gully control needed under all systems of cropping.

See footnotes at end of table.

TABLE 3.—*Soils of Fillmore County arranged by capability units, and suggested cropping systems and practices for control of erosion and water*—Continued

NOT SUITABLE FOR CULTIVATION

Capability unit and soils	Fertility management	Most intensive suitable cropping system	Practices for control of erosion and water
VIe-1 Dubuque and Whalan silt loams, shallow, slightly or moderately eroded, 12 to 17 percent slopes. Fayette silt loam, severely eroded, 12 to 17 percent slopes. Rockton and Dodgeville silt loams, shallow, eroded, 12 to 17 percent slopes. Schapville silt loam and silty clay loam, slightly or moderately eroded, 12 to 17 percent slopes. Sogn silt loam, eroded, 7 to 11 percent slopes. Tama and Downs silt loams, severely eroded, 12 to 17 percent slopes. Tama and Downs silt loams, 18 to 35 percent slopes.	Pasture renovation, including disking, fertilizing, and seeding to a grass mixture that provides grazing a greater part of the year.	Permanent pasture	Gully control.
VIw-1 Mixed alluvial land, 0 to 6 percent slopes.	Controlled grazing, pasture renovation, woodland management.	Permanent pasture	Stream protection and dikes where feasible.
VIIe-1 Dubuque and Whalan silt loams, shallow, severely eroded, 12 to 17 percent slopes. Dubuque and Whalan silt loams, shallow, 18 to 45 percent slopes. Fayette silt loam, slightly or moderately eroded, 18 to 45 percent slopes. Lindstrom silt loam and fine sandy loam, 18 to 45 percent slopes. Rockton and Dodgeville silt loams, shallow, 18 to 35 percent slopes. Steep rocky land.	Controlled grazing. Pasture renovation. Woodland management.	Permanent pasture	Gully control.
VIIs-1 Chelsea and Boone loamy fine sands, 12 to 17 percent slopes. Chelsea and Boone loamy fine sands, 18 to 35 percent slopes. Dakota fine sandy loam, eroded, shallow, 12 to 17 percent slopes. Escarpments. Hixton fine sandy loam, slightly or moderately eroded, 12 to 35 percent slopes. Mixed alluvial land, 7 to 17 percent slopes.	Fire control. Plant open areas to trees.	Woodland	Gully control.

[1] Contouring is suggested only for slopes of less than 200 feet. On longer slopes use stripcropping or terracing.

[2] Additional row crops may be added if crop residues are returned and enough fertilizer is applied.

and land types are droughty and generally shallow. Some are eroded. These are the units mapped:

- Chelsea and Boone loamy fine sands, 12 to 17 percent slopes (Ce).
- Chelsea and Boone loamy fine sands, 18 to 35 percent slopes (Cf).
- Dakota fine sandy loams, eroded, shallow, 12 to 17 percent slopes (Dd).
- Escarpments (Ea).
- Hixton fine sandy loam, slightly or moderately eroded, 12 to 35 percent slopes (Hb).
- Mixed alluvial land, 7 to 17 percent slopes (Me).

These soils and the land type are not suited to pasture or to cultivated crops. They are best for pine trees. The areas are favorable to wildlife. Control erosion by careful management.

Cropping Systems and Estimated Yields

Suitable crop rotations or cropping systems, with practices for control of erosion and water, are given in table 3 for the capability units already discussed. Table 4 provides estimated average acre yields under two levels of management. In columns A are yields to be expected under prevailing management, which includes rotation of crops, some practices for control of erosion, some use of legumes to restore organic matter and nitrogen, and limited application of commercial fertilizer, lime, and barnyard manure. Yields in columns B can be expected if selected water control and fertility practices are applied more intensively.

TABLE 4.—*Estimated average acre yields of the principal crops under (A) prevailing and (B) improved management*[1]

Soil	Map symbol	Corn		Oats		Soybeans		Red clover and timothy		Alfalfa		Pasture	
		A	B	A	B	A	B	A	B	A	B	A	B
		Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Cow-acre-days*[2]	*Cow-acre-days*[2]
Alluvial land, medium textured, poorly drained[3]	Aa	30	50	20	30	20	30	1.5	2.0	----	----	160	180
Alluvial land, medium textured, well drained	Ab	60	90	40	50	20	30	1.8	2.5	2.0	2.5	180	220
Alluvial land, coarse textured, well drained	Ac	50	80	30	40	16	25	1.5	2.2	1.7	2.2	160	200
Chaseburg and Judson silt loams, 0 to 1 percent slopes	Ca	60	90	40	60	18	25	2.0	3.0	2.5	3.5	200	250
Chaseburg and Judson silt loams, 2 to 6 percent slopes	Cb	55	85	35	55	15	22	1.8	2.8	2.3	2.2	190	230
Chelsea and Boone loamy fine sands, 2 to 6 percent slopes	Cc	15	30	15	25	8	10	1.0	1.5	1.7	2.0	80	100
Chelsea and Boone loamy fine sands, slightly or moderately eroded, 7 to 11 percent slopes.	Cd	12	25	12	22	6	8	.7	1.2	1.3	1.6	70	90
Chelsea and Boone loamy fine sands, 12 to 17 percent slopes	Ce	----	----	----	----	----	----	.4	.7	.8	1.0	60	80
Chelsea and Boone loamy fine sands, 18 to 35 percent slopes	Cf											40	60
Clyde silty clay loam[3]	Cg	45	65	30	40	20	30	1.5	2.0	----	----	160	180
Clyde silty clay loam, overwash	Ch	50	70	30	40	22	33	1.5	2.0	----	----	160	180
Dakota fine sandy loam, shallow, 0 to 1 percent slopes	Da	30	40	25	35	14	18	1.2	1.5	1.7	2.2	120	180
Dakota fine sandy loam, shallow, 2 to 6 percent slopes	Db	30	40	25	35	13	17	1.2	1.5	1.7	2.2	120	180
Dakota fine sandy loam, eroded, shallow, 2 to 6 percent slopes	Dc	25	35	22	32	10	15	1.1	1.4	1.6	2.1	110	170
Dakota fine sandy loam, eroded, shallow, 12 to 17 percent slopes.	Dd	20	30	20	30	8	12	1.0	1.3	1.5	2.6	100	160
Dakota loam, 0 to 1 percent slopes	De	35	45	30	38	15	20	1.5	2.0	1.8	2.4	140	180
Dakota loam, 2 to 6 percent slopes	Df	30	40	27	35	13	18	1.2	1.7	1.5	2.0	130	170
Dickinson fine sandy loam, 0 to 6 percent slopes	Dg	20	30	18	30	12	16	1.0	1.5	1.5	2.0	110	160
Dickinson fine sandy loam, eroded, 2 to 6 percent slopes	Dh	18	27	15	25	10	14	.8	1.3	1.3	1.7	100	150
Dickinson fine sandy loam, eroded, 7 to 11 percent slopes	Dk	15	25	12	22	8	12	.7	1.2	1.2	1.6	95	145
Dickinson fine sandy loam, moderately deep, 2 to 6 percent slopes.	Dl	25	35	20	30	14	20	1.2	1.6	1.8	2.3	130	170
Dickinson fine sandy loam, moderately deep, eroded, 2 to 6 percent slopes.	Dm	22	32	18	26	12	18	1.0	1.4	1.5	2.0	120	160
Dickinson fine sandy loam, moderately deep, eroded, 7 to 11 percent slopes.	Dn	20	30	15	25	10	15	.8	1.2	1.2	1.7	110	150
Dickinson loam, 2 to 6 percent slopes	Do	35	45	30	35	20	25	1.5	2.0	2.0	2.7	160	190
Dickinson loam, eroded, 2 to 6 percent slopes	Dp	30	40	25	30	18	23	1.2	1.7	1.7	2.4	150	180
Dickinson loam, eroded, 7 to 11 percent slopes	Dr	20	30	15	25	10	15	.8	1.2	1.2	1.7	110	150
Dubuque and Whalan silt loams, shallow, 2 to 6 percent slopes.	Ds	30	40	25	30	12	14	1.5	2.0	2.0	2.5	150	180
Dubuque and Whalan silt loams, shallow, eroded, 2 to 6 percent slopes.	Dt	25	35	20	25	10	12	1.2	1.7	1.5	2.0	120	160
Dubuque and Whalan silt loams, shallow, eroded, 7 to 11 percent slopes.	Du	20	30	15	20	8	10	1.0	1.5	1.2	1.6	100	140
Dubuque and Whalan silt loams, shallow, slightly or moderately eroded, 12 to 17 percent slopes.	Dv	----	----	----	----	----	----	.7	1.0	1.0	1.3	80	110
Dubuque and Whalan silt loams, shallow, severely eroded, 12 to 17 percent slopes.	Dw	----	----	----	----	----	----	----	----	----	----	70	100
Dubuque and Whalan silt loams, shallow, 18 to 45 percent slopes.	Dx	----	----	----	----	----	----	----	----	----	----	60	80
Escarpments	Ea	----	----	----	----	----	----	----	----	----	----	----	----
Fayette silt loam, 0 to 1 percent slopes	Fa	60	90	45	55	18	22	2.0	3.0	2.4	3.2	190	220
Fayette silt loam, 2 to 6 percent slopes	Fb	60	90	45	55	18	22	2.0	3.0	2.4	3.2	190	220
Fayette silt loam, eroded, 2 to 6 percent slopes	Fc	55	85	40	50	15	19	1.7	2.7	2.1	2.9	180	210
Fayette silt loam, eroded, 7 to 11 percent slopes	Fd	45	70	35	45	14	18	1.7	2.4	1.9	2.7	175	205
Fayette silt loam, severely eroded, 7 to 11 percent slopes	Fe	40	65	30	40	12	16	1.5	2.2	1.7	2.5	170	200
Fayette silt loam, eroded, 12 to 17 percent slopes	Ff	35	60	26	36	10	14	1.4	2.1	1.6	2.4	165	195
Fayette silt loam, severely eroded, 12 to 17 percent slopes	Fg	----	----	----	----	----	----	1.2	1.8	1.4	2.2	160	190
Fayette silt loam, slightly or moderately eroded, 18 to 45 percent slopes.	Fh	----	----	----	----	----	----	1.0	1.8	1.2	2.0	150	180
Fayette silt loam, terrace, 2 to 6 percent slopes	Fk	55	85	40	50	15	20	1.8	2.5	2.0	2.7	170	210
Fayette silt loam, terrace, eroded, 2 to 6 percent slopes	Fl	50	80	35	45	12	17	1.5	2.2	1.7	2.4	160	200
Fayette silt loam, terrace, erôded, 7 to 17 percent slopes	Fm	35	50	25	32	10	15	1.2	2.0	1.5	2.2	140	180
Floyd and Clyde silty clay loams, overwash, 0 to 3 percent slopes[3].	Fn	50	60	35	42	23	32	1.7	2.0	----	----	180	200
Hixton fine sandy loam, slightly or moderately eroded, 2 to 11 percent slopes.	Ha	20	35	15	25	10	14	1.2	1.6	2.0	2.5	100	140
Hixton fine sandy loam, slightly or moderately eroded, 12 to 35 percent slopes.	Hb	----	----	----	----	----	----	----	----	----	----	60	80
Kasson silt loam, 0 to 1 percent slopes	Ka	50	80	35	45	18	22	2.0	2.7	2.2	3.0	190	220
Kasson silt loam, 2 to 6 percent slopes	Kb	45	75	30	40	15	20	1.7	2.4	2.0	2.6	180	210
Kato silty clay loam	Kc	45	55	30	38	20	30	1.5	1.8	----	----	170	190
Kenyon silt loam, 0 to 1 percent slopes	Kd	65	100	50	60	20	25	2.5	3.0	3.0	3.8	200	250
Kenyon silt loam, 2 to 6 percent slopes	Ke	60	95	45	55	17	23	2.5	3.0	2.7	3.5	190	240
Lindstrom silt loam and fine sandy loam, 2 to 6 percent slopes.	La	60	80	40	50	16	22	2.2	2.8	2.7	3.5	190	240

See footnotes at end of table.

TABLE 4.—*Estimated average acre yields of the principal crops under (A) prevailing and (B) improved management*[1]—Continued

Soil	Map symbol	Corn		Oats		Soybeans		Red clover and timothy		Alfalfa		Pasture	
		A	B	A	B	A	B	A	B	A	B	A	B
		Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Cow-acre-days*[2]	*Cow-acre-days*[2]
Lindstrom silt loam and fine sandy loam, 7 to 11 percent slopes.	Lb	50	70	35	45	15	20	2.0	2.6	2.3	3.0	180	220
Lindstrom silt loam and fine sandy loam, slightly or moderately eroded, 12 to 17 percent slopes.	Lc	---	---	---	---	---	---	1.5	2.0	1.7	2.5	160	200
Lindstrom silt loam and fine sandy loam, 18 to 45 percent slopes.	Ld	---	---	---	---	---	---	---	---	---	---	80	110
Marshan silty clay loam [3]	Ma	40	60	25	35	16	22	1.5	2.0	---	---	160	180
Meridian fine sandy loam, 0 to 1 percent slopes	Mb	30	40	22	32	14	18	1.2	1.5	1.7	2.2	120	170
Meridian fine sandy loam, slightly or moderately eroded, 2 to 6 percent slopes.	Mc	25	35	20	30	12	16	1.0	1.3	1.5	2.0	110	160
Mixed alluvial land, 0 to 6 percent slopes	Md	20	40	15	22	10	15	1.0	1.5	1.5	2.0	110	140
Mixed alluvial land, 7 to 17 percent slopes	Me	---	---	---	---	---	---	---	---	---	---	80	110
Plainfield and Sparta loamy fine sands, slightly or moderately eroded, 2 to 6 percent slopes.	Pa	15	30	15	25	8	12	1.0	1.5	1.7	2.0	80	100
Plainfield and Sparta loamy fine sands, eroded, 7 to 11 percent slopes.	Pb	12	25	12	20	6	10	.8	1.2	1.5	1.8	70	90
Peat and muck [3]	Pc	45	65	30	40	25	35	---	---	---	---	100	140
Racine and Ostrander silt loams and loams, 0 to 1 percent slopes.	Ra	50	85	40	50	15	22	2.0	2.7	2.5	3.0	170	210
Racine and Ostrander silt loams and loams, 2 to 6 percent slopes.	Rb	50	80	35	45	18	20	1.8	2.5	2.2	2.7	160	200
Racine and Ostrander silt loams and loams, eroded, 2 to 6 percent slopes.	Rc	45	75	30	40	12	18	1.6	2.3	2.0	2.5	155	190
Racine and Ostrander silt loams and loams, eroded, 7 to 11 percent slopes.	Rd	40	60	25	35	10	16	1.5	2.2	1.8	2.3	150	180
Racine and Ostrander silt loams and loams, eroded, 12 to 17 percent slopes.	Re	---	---	---	---	---	---	1.2	1.7	1.5	2.0	130	160
Renova silt loam and loam, 0 to 1 percent slopes	Rf	50	75	35	45	16	20	1.7	2.5	2.0	2.7	170	200
Renova silt loam and loam, 2 to 6 percent slopes	Rg	50	75	35	45	14	18	1.7	2.5	2.0	2.7	170	200
Renova silt loam and loam, eroded, 2 to 6 percent slopes	Rh	45	70	30	40	12	16	1.5	2.2	1.7	2.5	160	190
Renova silt loam and loam, eroded, 7 to 11 percent slopes	Rk	35	60	25	35	10	14	1.2	2.0	1.5	2.2	140	170
Renova silt loam and loam, eroded, 12 to 17 percent slopes	Rl	---	---	---	---	---	---	.8	1.3	1.0	1.5	100	140
Rockton and Dodgeville silt loams, shallow, 2 to 6 percent slopes.	Rm	35	45	30	40	14	18	1.6	2.0	2.0	2.6	150	180
Rockton and Dodgeville silt loams, shallow, eroded, 2 to 6 percent slopes.	Rn	30	40	25	35	10	15	1.2	1.7	1.7	2.2	140	170
Rockton and Dodgeville silt loams, shallow, eroded, 7 to 11 percent slopes.	Ro	25	35	20	30	8	12	1.0	1.5	1.5	2.0	120	150
Rockton and Dodgeville silt loams, shallow, eroded, 12 to 17 percent slopes.	Rp	---	---	15	20	---	---	.8	1.2	1.2	1.7	100	130
Rockton and Dodgeville silt loams, shallow, 18 to 35 percent slopes.	Rr	---	---	---	---	---	---	---	---	---	---	60	80
Schapville silt loam and silty clay loam, 2 to 6 percent slopes	Sa	30	40	20	30	12	14	1.5	2.0	2.0	2.5	150	180
Schapville silt loam and silty clay loam, 7 to 11 percent slopes	Sb	25	35	15	25	10	12	1.2	1.7	1.5	2.0	130	160
Schapville silt loam and silty clay loam, slightly or moderately eroded, 12 to 17 percent slopes	Sc	---	---	---	---	---	---	.7	1.0	1.0	1.5	100	130
Seaton and Port Byron silt loams, eroded, 2 to 6 percent slopes.	Sd	40	60	30	40	12	18	1.5	2.2	2.0	2.7	160	190
Seaton and Port Byron silt loams, eroded, 7 to 11 percent slopes.	Se	30	50	25	35	10	15	1.2	2.0	1.5	2.2	150	180
Seaton and Port Byron silt loams, eroded, 12 to 17 percent slopes.	Sf	---	---	---	---	---	---	1.0	1.7	1.2	2.0	130	160
Skyberg silt loam, 0 to 3 percent slopes	Sg	40	70	30	40	15	20	1.5	2.2	---	---	180	210
Sogn silt loam, 0 to 6 percent slopes	Sh	15	25	12	20	10	15	1.0	1.5	1.5	1.8	100	140
Sogn silt loam, eroded, 7 to 11 percent slopes	Sk	---	---	---	---	---	---	.7	1.1	1.0	1.5	80	110
Steep rocky land	Sl	---	---	---	---	---	---	---	---	---	---	---	---
Tama and Downs silt loams, 0 to 1 percent slopes	Ta	65	100	50	60	20	25	2.5	3.0	3.0	3.8	200	250
Tama and Downs silt loams, 2 to 6 percent slopes	Tb	65	100	50	60	20	25	2.5	3.0	3.0	3.8	200	250
Tama and Downs silt loams, eroded, 2 to 6 percent slopes	Tc	60	90	45	55	16	20	2.2	2.8	2.7	3.5	190	240
Tama and Downs silt loams, 7 to 11 percent slopes	Td	60	80	40	50	15	18	2.0	2.5	2.5	3.0	180	220
Tama and Downs silt loams, eroded, 7 to 11 percent slopes	Te	50	70	35	45	12	16	1.5	2.2	2.0	2.5	170	210
Tama and Downs silt loams, 12 to 17 percent slopes	Tf	---	---	---	---	---	---	1.2	1.7	1.8	2.2	160	200
Tama and Downs silt loams, eroded, 12 to 17 percent slopes	Tg	---	---	---	---	---	---	1.0	1.5	1.5	2.0	150	180
Tama and Downs silt loams, severely eroded, 12 to 17 percent slopes.	Th	---	---	---	---	---	---	---	---	---	---	120	140
Tama and Downs silt loams, 18 to 35 percent slopes	Tk	---	---	---	---	---	---	---	---	---	---	100	120
Thurston and Wykoff loams, moderately deep, 0 to 1 percent slopes.	Tl	30	40	25	30	12	18	1.3	1.8	1.7	2.2	150	180
Thurston and Wykoff loams, moderately deep, eroded, 2 to 6 percent slopes.	Tm	25	35	20	25	10	15	1.0	1.5	1.5	2.0	130	160

See footnotes at end of table.

TABLE 4.—*Estimated average acre yields of the principal crops under (A) prevailing and (B) improved management*[1]—Continued

Soil	Map symbol	Corn		Oats		Soybeans		Red clover and timothy		Alfalfa		Pasture	
		A	B	A	B	A	B	A	B	A	B	A	B
		Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Cow-acre-days*[2]	*Cow-acre-days*[2]
Thurston and Wykoff loams, moderately deep, eroded, 7 to 17 percent slopes.	Tn	20	30	15	20	8	12	.7	1.1	1.3	1.8	100	130
Thurston and Wykoff sandy loams, shallow, 0 to 1 percent slopes.	To	20	35	20	25	10	15	1.2	1.7	1.5	2.0	140	170
Thurston and Wykoff sandy loams, shallow, eroded, 2 to 6 percent slopes.	Tp	18	30	18	23	8	13	1.0	1.5	1.3	1.8	130	160
Thurston and Wykoff sandy loams, shallow, eroded, 7 to 11 percent slopes.	Tr	15	25	12	17	6	10	.7	1.0	1.0	1.5	100	130
Waukegan silt loam, 0 to 1 percent slopes	Wa	55	75	35	45	16	22	2.0	2.6	2.5	3.0	180	220
Waukegan silt loam, 2 to 6 percent slopes	Wb	50	65	30	40	14	20	1.5	2.0	2.2	2.7	170	210

[1] See text for definitions of prevailing management and improved management. Absence of yield figure indicates that crop is not commonly grown under management specified.

[2] Cow-acre-days is the number of days per year that one acre will support a cow without injury to the pasture.

[3] Sufficiently drained for crop production.

Principles of Management

Successful management of a farm requires proper use of the soils. A system should be planned that takes into account maintenance of soils for continued production, hazards to be expected, and equipment and other resources available.

Some of the important basic principles of soil management are discussed in the following pages. They are part of the Minnesota Soil Fertility and Conservation Program.

Knowing Soil Characteristics

It is important to know the characteristics of a soil that affect its use, management, and productivity. Texture, structure, slope, natural drainage, degree of erosion, and content of minerals and organic matter must be considered.

Texture refers to the relative proportion of sand, silt, and clay in a soil. A loamy sand, for example, contains a higher proportion of sand than either silt or clay. A silt loam is one-half to three-quarters silt and about equal amounts of sand and clay.

A soil with a high content of sand is very porous, loose, and friable. It is easy to cultivate, but its moisture-holding capacity is low. Water percolates rapidly through the loose sand, and there are few fine particles (silt and clay) to hold the water. Soils that are extremely sandy, the Chelsea and Boone soils, for example, are generally deficient in both water and plant nutrients.

In contrast, a soil of high clay content is fairly impervious to water, is highly plastic, and often is difficult to work. A soil containing a fair amount of clay may be well supplied with plant nutrients. These nutrients may have come from the parent materials of the soil, or they may have been released through weathering of minerals in the soil. Clay particles absorb both water and minerals, store them, and release them as they are needed by plants. The moisture-holding capacity of a clay soil is generally high.

Structure of a soil is the arrangement of particles into aggregates or peds. A soil with favorable structure is friable, porous, and easy to cultivate. But a soil with unfavorable structure is poorly drained and difficult to work.

Farmers frequently remark that their clay soils are getting heavier, cracking in dry weather, and are becoming difficult to work. This indicates that the soils are losing their granular structure and are becoming compact and impervious. Intense cropping has caused the soils to deteriorate, and a change in management is needed.

Although sandy soils ordinarily have favorable structure, they commonly need practices that will control erosion and conserve water.

Drainage is the movement of water on and in the soils. The rate at which the water is removed, and the extent to which it is removed, determines the drainage class. Poorly drained soils are wet much of the time. Air cannot circulate freely. Mottling reflects poor drainage. Artificial drainage is generally needed to produce crops successfully on mottled soils.

Well-drained soils are generally free of mottles, and they have a bright uniform color. Water is removed from them readily, and they are permeable to air and roots.

Deep sandy soils are excessively drained. Water passes rapidly through them, and they retain little moisture.

Applying artificial drainage.—An important part of any good soil management is the provision of adequate drainage systems for poorly drained level and depressed areas that are otherwise well suited to crops. Poor drainage restricts movement of air and water through the soil and thus affects the development of plant roots. If drainage is good, plant roots can receive enough oxygen to develop normally. Well-drained soils warm up earlier in spring than poorly drained soils and are less subject to frost heaving.

Drainage systems are usually complex, and they ordinarily require study by a drainage engineer. On many soils their construction is not easy and requires considerable initial outlay. Nevertheless, artificial drainage is recommended, where practical, for soils that will benefit from it. The Floyd and Clyde soils are good examples of soils well suited to tiling.

Tile drains are more effective on friable soils than on heavy-textured soils. If tile drains are used on the Skyberg soil or on other fairly impervious clay soils, they should be spaced closer than in more permeable soils. Open ditches are commonly used to remove surface water from areas that cannot be tiled or otherwise drained.

Cultivating the soils.—Cultivation, if correctly practiced, generally promotes a desirable environment for plant development. It aerates, improves tilth, provides seedbeds, conserves moisture by controlling weeds, and partially incorporates manure and crop residue.

Liming acid soils.—Most of the cropland in Fillmore County is too acid for satisfactory growth of alfalfa or clovers. Generally the farmer must neutralize the soils with lime to produce good crops. Tests should be made before liming to determine the actual need, because the degree of acidity varies. The amount of lime needed to obtain the desired results depends upon the following factors: (1) crops to be grown, (2) reaction of the soil, (3) soil type, and (4) depth to the subsoil layer that contains lime.

The reaction of sandy soils can be changed with rather light applications of lime. Heavier applications are needed to make the same change in silt loams, and still heavier applications are needed in silty clay loams and clays. Heavy applications are also needed for peat soils and other organic soils. Ground limestone is usually the most economical form of lime to use.

Following a crop rotation.—A good crop rotation is essential to any system that will maintain fertility and conserve the soils. Proper rotation of crops (1) systematizes farming, (2) increases crop yields, (3) aids in maintaining the supply of nitrogen and organic matter in the soil, (4) helps in controlling weeds, insects, and plant diseases, (5) keeps the soil occupied a greater part of the time, and (6) saves labor and distributes it more efficiently.

Continued production of corn and other row crops causes poor soil structure and tends to lower the content of plant nutrients. Greater care is needed to prevent soil deterioration when row crops are grown continuously than when they are grown in rotation with soil-building crops. The soil-depleting crops grown in the county are corn, soybeans for grain, and small grains. The soil-building crops are legumes and grasses grown for hay and pasture. The proportion of row crops to the legumes and grasses is the most important consideration in choosing a crop rotation. The balance between soil-depleting and soil-conserving crops will determine the fertility level of the soil and the extent to which erosion can be controlled.

Maintaining organic matter.—Organic matter is often called the life of the soil. It affects the tilth and chemistry of the soil and is the source of food and energy for micro-organisms. Organic matter includes the decomposed products of roots, stems, leaves, and other plant residues, and also dead micro-organisms and insects.

Organic matter performs the following functions: (1) Promotes soil aggregation and increases the stability of the aggregates formed; (2) holds reserve supplies of plant nutrients; (3) increases the resistance of the soil to erosion; (4) increases biological activity by providing food and energy for the micro-organisms in the soil; (5) improves soil-water-plant relations by increasing the depth of arable soil, and by increasing the volume of the soil-water reservoir.

Organic matter should be maintained and, in many soils, increased. This can be done by adding barnyard manure, turning under crop residues and green manure, and by using a longer rotation that includes two or more years of legumes or grasses.

Adding commercial fertilizers.—Commercial fertilizers are being used increasingly in Fillmore County. Plant nutrients are constantly being removed from the soils by crops, erosion, and leaching. They must be replaced. Commercial fertilizers should be applied, especially if manure is scarce and the soils are naturally low in available minerals.

Nitrogen, phosphorus, and potassium and small amounts of many other elements are all essential to plant growth. The inability of plants to obtain an adequate supply of one or more nutrients may seriously limit plant growth. Adding the needed nutrient to the soil will usually result in healthier, higher yielding, and earlier maturing plants.

Sandy soils are generally deficient in organic matter, nitrogen, and potassium. Adding nitrogen and potassium in the form of commercial fertilizers is a profitable practice on sandy soils planted to row crops. Hay and pasture usually respond also to additions of phosphorus. Even fertile soils may need an occasional application of commercial fertilizers.

More specific information about fertilizer and lime requirements of the different soils of the county can be obtained from the Minnesota Agricultural Experiment Station or from the county agricultural agent.

Controlling erosion.—Erosion control and water conservation are needed if losses of soil and water are to be kept to a minimum. Practices that maintain or increase soil productivity also conserve soil and water. To prevent erosion by wind and water, it may be necessary to practice terracing, contour tilling, stripcropping, and the sodding of waterways. Blowing of sandy soils can be checked by keeping them under a plant cover, by leaving crop residues on the surface, and by rough tillage. Windbreaks are useful protection for the areas most exposed to wind.

Stripcropping is one of the most common practices used in this county to control sheet erosion. Contour stripcropping, with a good crop rotation that includes 2 to 4 years of hay, is probably one of the best control measures for cultivated fields. If the strips are properly laid out, they will control erosion well on slopes that are not excessive. The width of the strips depends upon the slope, soil type, tilth, degree of erosion, and the crops in the rotation. Tilling and plowing on the contour will conserve both soil and water and generally increase yields.

Terraces provide permanent protection against erosion on cultivated fields. They are particularly suitable for long gentle slopes where intensive crop rotations are used. Terraces reduce the length of slope. A whole field can be planted to one crop if it is terraced. In some areas, stripcropping and terracing are combined with good results. The width of the strips may be the width of one or more terrace intervals. Terracing alone provides better erosion control than stripcropping alone.

Grassed waterways to carry off surplus water are an essential part of contour tillage, stripcropping, and terracing. They are established best by seeding the entire drainage area to meadow.

Crop rotations that include two or more years of hay are just as essential to erosion control as other practices. Short rotations, those lasting 2 to 3 years, are used on gentle slopes. For the steeper slopes, rotations lasting 4, 5, or even 6 years are suggested. Soil losses are low during the time the soil is protected by a close-growing crop. When a clean-cultivated crop is grown, losses are less if the crop is planted on a field where a hay meadow or pasture has been plowed under.

Improving pastures.—Pastures are important in any well-planned system of farm management. Pastures should supply adequate forage all through the season. To do this, they ordinarily will need to be of at least three kinds—permanent, rotation, or supplementary. Rotation pastures that consist of a mixture of grasses and legumes generally yield the best.

Land not suited to cropping should be used for permanent pasture. Such land is normally too stony, too steep, or too wet for cultivation. On some farms, however, land suitable for hay and cultivated crops may have to be used for permanent pasture.

Rotation pastures generally yield more than permanent pastures because they are on better soils, to which barnyard manure is commonly applied. Mixtures of alfalfa and timothy or of alfalfa and bromegrass are the best. These mixtures produce pasture of good quality and yield about twice as much as unimproved permanent pastures. Good agricultural land is ordinarily used part of the time for rotation pasture and for supplementary pasture.

Supplementary pastures can be used to produce forage during periods when permanent or rotation pastures do not provide enough feed. Winter rye, sudangrass, and spring-sown small grains are commonly used. Second-crop alfalfa also can be used for supplementary pasture during July and August.

Many pastures in Fillmore County are poor because of overgrazing, sheet and gully erosion, lowered fertility, weeds, and brush. These pastures should be improved to increase yield and to protect the land from erosion. Yields of permanent pastures can be improved greatly under good management. Controlled grazing protects pasture plants. Livestock can be shifted from one pasture to another. Weeds should be clipped and brush destroyed; droppings should be spread by harrowing.

Fertility can be maintained or improved by applying lime and commercial fertilizers when the pastures are reseeded. Manure can be used to supplement commercial fertilizers, or used alone. For seeding, a legume-grass mixture is better than a legume or a grass alone.

The establishment and maintenance of good plant cover is the best conservation measure. In addition, however, on some badly eroded and gullied sites, other supporting practices, such as contour furrows, contour tillage, and pasture terraces, may be advisable. For additional information concerning the establishment and maintenance of good pasture consult your county agricultural agent or write to the Bulletin Room, University Farm, St. Paul 1, Minnesota.

Genesis and Morphology of Soils

The kind of soil that develops depends on the interaction of parent materials, climate, relief, vegetation, and time. These combined factors affect soil formation and give the soil distinct horizons. During the process of transformation, minerals disintegrate, new minerals and new chemical compounds form, organic matter accumulates and decomposes, and materials in suspension and solution move downward in the soil and are partly removed by drainage waters.

Morphology is the physical constitution of the soil, including the texture, structure, consistence, color, and other physical and chemical properties of the various horizons that make up the soil profile. Many soils of the county on comparable topography have similar morphological characteristics, such as depth of solum, color, and content of organic matter. The similarity probably results because climate, vegetation, parent material, and topography are fairly uniform in the county. The time factor is not so important in explaining differences in soils of the county because, except for some relatively recently transported materials, the parent materials were deposited at approximately the same time.

The principal soils of Fillmore County have developed from loess and glacial till in a moderately humid climate, under the varying influence of both tree and grass vegetation. Soil profiles clearly illustrate the influence of climate and vegetation.

Parent Materials

The two most extensive parent materials from which the soils of the county have developed are Iowan glacial till and Peorian loess. Others are glacial outwash deposits, sandy and gravelly materials of the uplands, residuum, alluvium, and colluvium. Parent materials are largely responsible for the texture and chemical and mineralogical composition of the soils.

Peorian loess, deposited during or shortly after the retreat of the Iowan ice, covers a large part of the county. In some places, the deposit of loess over bedrock is thin, particularly near streams in the highly dissected eastern part. These homogeneous deposits commonly contain a fairly large proportion of silts, which have given rise to very silty soils.

Glacial drift, deposited by the melting Iowan ice, is confined to parts of eight western and southwestern townships. In the extreme western and northwestern part of this area, on the smooth drift plains, deposits of till are relatively thick. A comparatively narrow belt of thin glacial deposits stretches along the eastern margin of the glaciated region. The shallow glacial till overlies horizontally bedded limestones. Unlike the loess, these deposits contain a mixture of sand, silt, and clay particles which give a variable texture to the soils.

Sandy and gravelly materials and boulders are common on the uplands in the glaciated region. They sometimes occur on kamelike knolls and ridges or as narrow, somewhat continuous streaks.

Glacial outwash deposits are few and occur mainly along the upper Iowa River and tributaries of the Root River. They are usually stone-free stratified deposits containing both sand and gravel. Most of these deposits are acid, because the lime has been leached to considerable depth. Many deposits, underlain in places by finer material, are almost pure sand.

Residuum weathered from limestone, sandstone, or shale is prevalent in the dissected areas, especially in the eastern part of the county, where geologic erosion has removed much of the surface soil. Limestone and sandstone bedrock are commonly exposed in these areas.

Alluvium, consisting of mixtures of sand, gravel, silt, and clay, has been deposited in the valleys of all the major streams and some of their tributaries. These relatively fresh deposits show little evidence of soil development.

Colluvial deposits, largely of silty material, occur along the upper drainageways on the uplands. Soils formed from them are generally silty in texture and are not well developed.

Climate

Climate affects the physical, chemical, and biological relationships in the soil. The amount of water that actually percolates through the soil is dependent upon rainfall, relative humidity, and the frost-free period. Water is active in dissolving minerals and carrying them out of the soil. The surface layer of most soils in humid regions is impoverished through the leaching action of water. Temperature influences the growth of organisms and the speed of chemical reactions in soils.

The climate is fairly uniform throughout Fillmore County. Microclimatic variations provide different environments and influence the soil-forming processes to such an extent that the soils formed under them differ in certain characteristics from those developed under the prevailing macroclimate.

Topography

Topography influences soil formation through its effect on water relations, erosion, temperature relations, and plant cover. The topographic features of an area are determined by the underlying bedrock formations, climate, vegetation, and other factors. The effect of topography on soil is dependent, to a large extent, on the other four factors of soil formations.

Topography affects thickness and organic-matter content of the A horizons, depth of solum, drainage (especially coloration and degree of mottling), and degree of horizon differentiation. For example, soils derived from the one kind of parent material will classify as Lithosols on the steeper slopes, but as the slope decreases, will successively be darker and deeper and have increasingly more clayey subsoils.

On the broad divides of the dissected upland areas, deep soils with well-developed horizons have formed. Shallower, less well developed soils derived from loess and a variety of sedimentary rocks occupy the valley slopes. On the valley floor are young soils developed from alluvium that washed from the adjacent uplands.

Living Organisms

Micro-organisms and vegetation are indispensable in soil development. Bacteria, fungi, and other micro-organisms aid in weathering rock and in decomposing organic matter. They influence the chemical and biological processes. Vegetation affects soil development by altering the soil microclimate, by incorporating residues in the soil, and by transferring elements from the subsoil to the surface horizons.

The type of natural vegetation largely depends on the environment created by the factors of climate and soil. Once established, vegetation exerts considerable influence on soil formation. In Fillmore County, one of the outstanding examples of the influence of vegetation on soil characteristics is the contrast between prairie soils and forest soils developed from the same kind of parent material. Certain areas originally supported forest vegetation, and others, prairies. The forested soils, to a depth of about 4 feet, contain less organic matter and have lower pH values and smaller amounts of exchangeable bases than the soils under grass. They also have a greater accumulation of colloids in the B horizon.

Time

The length of time required for soil development depends largely on the other factors of soil formation. Less time is required for soil development in humid, warm regions with luxuriant vegetation than in dry or cold regions with scanty vegetation. Also, less time is required for soil development on coarse-textured than on fine-textured parent materials. Glacial till deposits weather to form soils much faster than hard bedrock.

In Fillmore County, the parent materials are of several ages. Residual materials, from which some of the soils have developed, include Cretaceous gravels; Devonian limestones; Ordovician limestone, sandstone and shale; and Cambrian limestones and sandstones. Most of the soils, however, have developed from Peorian loess and Iowan glacial drift deposits. The Peorian is the interglacial period following the Iowan glacial subage.

Processes of Soil Formation

The main processes responsible for the development of Fillmore County soils are podzolization; calcification; gleization, or formation of gray layers in poorly drained soils; and decomposition of organic deposits, or formation of peat.

Podzolization is the dominant process in the soils of the county and leads to depletion of bases, development of acidity, and formation of eluvial A horizons and illuvial B horizons. The process goes on in a moderately cool and humid climate, under the influence of forest vegetation, and it results in the development of relatively light colored soils.

Gray-Brown Podzolic soils are a great soil group developed under the influence of the podzolization process. Fayette silt loam, developed from Peorian loess, is a representative of this great soil group. It has an A horizon that is low in organic matter and a somewhat fine-textured B horizon that is brighter in color than either the A or C.

Profile description of Fayette silt loam taken in a wooded area (SW¼SW¼ sec. 8, T. 101 N., R. 9 W.):

A_1 0 to 2½ inches, very dark grayish brown (10YR 3/2, moist) friable silt loam; moderately low in organic matter; fine to medium granular structure.

A_{21} 2½ to 8 inches, dark grayish-brown (10YR 4/2, moist) (light yellowish-brown when crushed) friable silt loam; weak fine platy structure.

A_{22} 8 to 12 inches, dark grayish-brown (10 YR 4/2, moist) to grayish-brown (10YR 5/2, moist) (light-gray when dry) silt loam; weak fine platy structure.

B_1 12 to 16 inches, brown (10YR 5/3, moist) (light yellowish-brown when crushed) silty clay loam; moderate fine subangular blocky structure; aggregates coated with light-gray fine material.

B_{21} 16 to 26 inches, dark brown (10YR 4/3, moist) silty clay loam; moderate fine subangular blocky structure; peds coated with light gray.

B_{22} 26 to 35 inches, dark-brown (10YR 4/3, moist) to dark yellowish-brown (10YR 4/4, moist) silty clay loam; strong medium subangular blocky structure; heavy coatings on peds.

C_1 35 to 60 inches +, yellowish-brown (10YR 5/4, moist) heavy silt loam; coarse blocky to massive structure; aggregates perforated with small tubular holes.

Prairie soils, developed under the dominant influence of tall prairie grasses, are less extensive in this county than the Gray-Brown Podzolic soils. They have developed through the process of calcification, with weak podzolization, in a region having a cool, moderately humid climate. The climate is similar to that in which Gray-Brown Podzolic soils develop. Although some leaching occurs in formation of Prairie soils, the native grasses, which formerly occupied these soils, returned sufficient calcium to the surface layers to prevent appreciable removal of bases and dispersion of colloids.

Tama silt loam, developed from the same parent material as Fayette silt loam, is a typical example of a Prairie soil. It has a deep A horizon, but unlike Fayette silt loam, the textural differentiation in the horizons is not appreciable. The surface layer is very dark brown and high in organic matter and bases. The color grades gradually through brown down to the lighter color of the loess parent material. Podzolization is evident in these soils. They are slightly acid and generally are leached somewhat, although not nearly so much as the Fayette soils.

Profile description of Tama silt loam (NW¼SE¼ sec. 10, T. 101 N., R. 8 W.):

A_1 0 to 13 inches, black (10YR 2/1, moist) to very dark brown (10YR 2/2, moist) friable silt loam; fine granular structure.

A_3 13 to 17½ inches, very dark grayish brown (10YR 3/2, moist) mellow silt loam; weak medium granular structure.

B_1 17½ to 22 inches, dark-brown (10YR 4/3, moist) heavy silt loam; moderate fine subangular blocky structure; peds crush to yellowish brown; slightly plastic when wet.

B_{21} 22 to 40 inches, dark yellowish-brown (10YR 4/4, moist) silty clay loam; fine to medium subangular blocky structure; peds have tubular pores; plastic when wet.

B_{22} 40 to 53 inches, yellowish-brown (10YR 5/4, moist) silty clay loam; medium subangular blocky structure; distinct clay skins on peds; plastic when wet.

C_1 53 to 75 inches, yellowish-brown (10YR 5/6, moist) light silty clay loam; more friable than layer above; massive structure.

C_2 75 to 88 inches, light yellowish-brown (10YR 6/4, moist) heavy silt loam; massive structure.

Humic Gley soils develop where soil material is saturated with water for long periods in the presence of organic matter. The process of gleization is indicated by a fine-textured, bluish-gray or greenish, commonly very compact and plastic layer. Normally, in gley soils, the water table is high much of the time and artificial drainage is needed for the growth of most plants.

Clyde silty clay loam, developed from glacial till material, is typical of a great group of soils called Humic Gley. The surface horizon is thick and the content of organic matter is high.

Profile description of Clyde silty clay loam (SE¼ NE¼ sec. 17, T. 101 N., R. 12 W.):

A_1 0 to 12 inches, black (2.5Y 2/0, moist) silty clay loam; weak fine crumb structure; plastic when wet.

A_g 12 to 15 inches, very dark grayish brown (2.5Y 3/2, moist) silty clay loam; moderate fine granular structure; plastic when wet.

B_g 15 to 23 inches, olive (5Y 5/4, moist) silty clay loam; highly mottled; mottles are fine, distinct, and yellowish brown (10YR 5/6, moist).

C_1 23 inches +, light olive-brown (2.5Y 5/4, moist) sandy clay loam to silty glacial till; pockets of sand; massive structure.

Classification of Soils

Table 5 lists the soil series of Fillmore County by great soil groups and gives the three factors of soil formation—topography, parent material, and vegetation—that are most variable. These factors have had the most influence in development of the different kinds of soils. Climate and time, the remaining soil-forming factors, are relatively uniform throughout the county and therefore are not listed in the table.

Many of the soils in this area do not have the characteristics that will allow their placement in any one great soil group. They possess characteristics of more than one great soil group, and this is shown in table 5.

TABLE 5.—*Soil series of Fillmore County, Minn., classified by higher categories, and some of the factors that have contributed to their morphology*

Great soil group and soil series	Topography		Parent material	Native vegetation
	Position on landscape	Slope range		
		Percent		
Gray-Brown Podzolic:				
Dubuque	Highly dissected loess-covered uplands	2–45	Thin deposit of Peorian loess underlain by limestone.	Mixed hardwoods: Chiefly oak and hickory.
Fayette	Dissected loess-covered uplands	0–45	Thick deposits of Peorian loess.	Hardwoods: Chiefly oak.
Fayette, terrace	Valleys and valley slopes	2–17	Peorian loess underlain by sand.	Mixed hardwoods.
Hixton	Valley slopes and talus positions on the uplands.	2–35	Residuum from sandstone (includes sandy colluvium).	Mixed hardwoods.
Meridian	Stream terraces	0– 6	Stratified sand and gravel.	Hardwoods: Oak and maple.
Renova	Dissected glacial uplands	0–17	Leached Iowan glacial till.	Mixed hardwoods: Oak and hickory.
Seaton	Margins of loess-covered uplands (knobs)	2–17	Coarse Peorian loess	Mixed hardwoods: Oak and hickory.
Whalan	Dissected glacial uplands	2–45	Thin deposit of glacial till underlain by limestone.	Mixed hardwoods: Chiefly oak.
Wykoff	Knobs on glacial uplands	0–17	Sorted glacial drift (coarse sands and gravel).	Chiefly oak.
Prairie:				
Dakota	Sandy outwash terraces	0–17	Moderately coarse textured sediments, underlain by sand and gravel.	Tall prairie grasses.
Dickinson	Sandy knobs on glacial uplands	0–11	Sorted glacial drift (sands).	Oak openings and tall prairie grasses.
Dodgeville	Dissected loess-covered uplands	2–35	Thin deposit of Peorian loess, underlain by limestone.	Tall prairie grasses.
Kenyon	Smooth glacial uplands	0– 6	Iowan glacial till	Tall prairie grasses.
Lindstrom	Loess-covered talus slopes of uplands	2–45	Dark-colored loess and silty colluvium.	Tall prairie grasses.
Ostrander	Smooth to dissected glacial uplands	0–17	Iowan glacial till (clay loam).	Tall prairie grasses.
Port Byron	Margins of loess-covered uplands (knobs)	2–17	Coarse Peorian loess	Tall prairie grasses, a few oaks.
Rockton	Smooth karst topography and dissected glacial uplands.	2–35	Thin glacial till underlain by limestone.	Tall prairie grasses, a few hardwoods.
Schapville	Benches on loess-covered uplands	2–17	Thin loess underlain by calcareous shales.	Wet prairie grasses, trees and shrubs.
Tama	Broad divides on loess-covered uplands	0–35	Deep silty Peorian loess.	Tall prairie grasses.
Thurston loam	Gravel knobs on glacial uplands	0–17	Coarse glacial drift (sands and gravel).	Tall prairie grasses.
Waukegan	River terraces and outwash valleys	0– 6	Silty sediments underlain by leached sand and gravel.	Tall prairie grasses.
Soils with characteristics of Gray-Brown Podzolic and Prairie soils:				
Downs	Divides on loess-covered uplands	0–35	Deep silty Peorian loess.	Mixture of prairie grasses and hardwoods.
Kasson	Smooth glacial uplands	0– 6	Deeply leached Iowan glacial till.	Mixture of prairie grasses and scattered hardwoods.
Racine	Smooth to dissected glacial uplands	0–17	Iowan glacial till	Mixed hardwoods (oak openings).
Regosols:				
Boone	Talus slopes and ledges in dissected uplands	2–35	Residuum from sandstone.	Oak-hickory-pine.

TABLE 5.—*Soil series of Fillmore County, Minn., classified by higher categories, and some of the factors that have contributed to their morphology.*—Continued

Great soil group and soil series	Topography		Parent material	Native vegetation
	Position on landscape	Slope range		
		Percent		
Escarpments	Rims of ridges in dissected uplands and terrace escarpments.	17–35	Variable: Chiefly loose sand and gravel.	Mixed hardwoods; redcedar.
Humic Gley:				
Clyde	Drainageways and depressions on glacial uplands.	0– 1	Iowan glacial till	Wet prairie grasses, sedges, marshgrasses.
Marshan	Drainageways and depressions of outwash plains.	0– 1	Moderately fine textured sediments underlain by sand and gravel.	Wet-land grasses and sedges.
Lithosols:				
Sogn	Disected uplands	0–11	Very thin loess or till, limestone, and calcareous residuum weathered from shale.	Redcedar, mixed hardwoods, and grasses.
Steep rocky land	Dissected steep rocky uplands and valley slopes.	12–45+	Rocks differentially weathered.	Mixed hardwoods; redcedar.
Alluvial soils:				
Alluvial land:				
Medium textured, poorly drained.	Flood plains and stream bottoms	0– 1	Medium textured alluvium.	Mixed hardwoods, sedges, and grasses.
Medium textured, well drained.	Flood plains and stream bottoms	0– 3	Medium textured alluvium.	Mixed hardwoods: Elm, ash, and maple.
Coarse-textured, well drained.	Flood plains and stream bottoms	0– 3	Coarse-textured alluvium.	Mixed hardwoods: Elm, ash, and maple.
Soils with characteristics of Regosols and Gray-Brown Podzolic soils:				
Chelsea	Talus slopes and valley-fill positions	2–35	Residuum from sandstone and acid loess.	Mixed hardwoods, pine, and some grasses.
Plainfield	River terraces	2–11	Stratified sandy material. dominantly quartz.	Pine and mixed hardwoods, chiefly oak.
Soils with characteristics of Regosols and Prairie soils:				
Sparta	River terraces	2–11	Stratified sandy material. dominantly quartz.	Oak openings, prairie grasses.
Thurston sandy loam.	Gravel knobs on glacial uplands	0–11	Sorted glacial drift (stratified gravel and sand).	Tall prairie grasses and a few oaks.
Soils with characteristics of Humic Gley and Prairie soils:				
Floyd	Smooth glacial uplands	0– 3	Iowan glacial till	Wet prairie grasses and sedges.
Kato	Glacial outwash terraces	0– 1	Moderately fine textured sediments underlain by sand and gravel.	Wet prairie grasses and sedges.
Soil with characteristics of Low-Humic Gley and Prairie soils:				
Skyberg	Nearly level glacial uplands	0– 3	Deeply leached firm Iowan glacial till.	Mixed lowland hardwoods and prairie grasses.

TABLE 5.—*Soil series of Fillmore County, Minn., classified by higher categories, and some of the factors that have contributed to their morphology*.—Continued

Great soil group and soil series	Topography		Parent material	Native vegetation
	Position on landscape	Slope range		
		Percent		
Soil with characteristics of Alluvial and Gray-Brown Podzolic soils:				
Chaseburg	Talus slopes and upland drainageways	0– 6	Silty colluvium-alluvium.	Mixed hardwoods.
Soil with characteristics of Alluvial and Prairie soils:				
Judson	Talus slopes and upland drainageways	0– 6	Silty colluvium-alluvium.	Tall prairie grasses.
Organic soils:				
Peat and muck	Bottom lands and lower seepage slopes	0– 3	Partially decomposed plant remains.	Wet grasses, sedges, and reeds.

How a Soil Survey is Made

The scientist who makes a soil survey examines soils in the field, classifies them in accordance with facts that he observes, and maps their boundaries on an aerial photograph or other map.

FIELD STUDY.—The soil surveyor bores or digs many holes to see what the soils are like. The holes are spaced irregularly according to the lay of the land. Usually they are not more than a quarter of a mile apart, and sometimes they are much closer. In most soils each boring or hole reveals several distinct layers, called horizons, which collectively are known as the soil profile. The profile is studied to see how the horizons differ from one another and to learn the things about the soil that influence its capacity to support plants.

Color is usually related to the amount of organic matter. The darker the surface soil, as a rule, the more organic matter it contains. Streaks and spots of gray, yellow, and brown in the lower layers generally indicate poor drainage and poor aeration.

Texture, or the content of sand, silt, and clay, is determined by the way the soil feels when rubbed between the fingers, and is later checked by laboratory analysis. Texture determines how well the soil retains moisture, plant nutrients, and fertilizer, and whether it is easy or difficult to cultivate.

Structure, which is the way the individual soil particles are arranged in aggregates, and the amount of pore space between aggregates, gives us clues to the ease or difficulty with which the soil is penetrated by plant roots and by moisture. The aggregates may have prismatic, columnar, blocky, platy, or granular structure.

Consistence, or the tendency of the soil to crumble or to stick together, indicates whether it is easy or difficult to keep the soil open and porous under cultivation.

Other characteristics observed in the course of the field study and considered in classifying the soil include the following: The depth of the soil over bedrock or compact layers; the presence of gravel or stones in amounts that will interfere with cultivation; the steepness and pattern of slopes; the degree of erosion; the nature of the underlying parent material from which the soil has developed; and acidity or alkalinity of the soil as measured by chemical tests.

CLASSIFICATION.—On the basis of the characteristics observed by the survey team or determined by laboratory tests, soils are classified by series, types, and phases.

As an example of classification, consider how the Dickinson series of Fillmore County is separated into types and phases:

Series	*Type*	*Phases*
Dickinson	Fine sandy loam	0 to 6 percent slopes.
		Eroded, 2 to 6 percent slopes.
		Moderately deep, 2 to 6 percent slopes.
		Moderately deep, eroded, 7 to 11 percent slopes.
	Loam	2 to 6 percent slopes.
		Eroded, 7 to 11 percent slopes.

Soil series.—Soils similar in kind, thickness, and arrangement of layers are normally designated as a soil series. In a given area, however, a soil series may be represented by only one soil.

Soil type.—Within a soil series, there may be one or more soil types. The soil types are determined by the texture of the surface layer.

Soil phases.—Soil types are divided into soil phases because of differences other than those of kind, thickness, and arrangement of layers. Slope variations, frequency of rock outcrops, degree of erosion, depth of soil over the substratum, or natural drainage are examples of characteristics that suggest dividing a soil type into phases.

The soil phase, or the soil type if it has not been subdivided, is the mapping unit on the soil map. It is the unit that has the narrowest range of characteristics. Use and management therefore can be specified more easily than for soil series or yet broader groups that contain more variation.

Miscellaneous land types.—Fresh stream deposits and rough, stony, or severely gullied land are not classified by types and series. They are identified by a descriptive name. Steep rocky land is a miscellaneous land type in Fillmore County.

Summary of important soil characteristics

Soil	Map symbol	Capability unit	Parent material	Drainage	Color (moist)	
					Surface soil	Subsoil
Alluvial land, medium textured, poorly drained.	Aa	IIIw-3	Medium-textured alluvium	Somewhat poor to poor	Very dark gray to black	Variable.
Alluvial land, medium textured, well drained.	Ab	IIw-3	Medium-textured alluvium	Good	Variable	Variable.
Alluvial land, coarse textured, well drained.	Ac	IIIw-3	Coarse-textured alluvium	Moderately good to good	Variable	Variable.
Chaseburg and Judson silt loams, 0 to 1 percent slopes.	Ca	IIw-1	Silty colluvium-alluvium	Good	Dark gray to dark grayish brown.	Brown to yellowish brown.
Chaseburg and Judson silt loams, 2 to 6 percent slopes.	Cb	IIw-1	Silty colluvium-alluvium	Good	Same	Brown to yellowish brown.
Chelsea and Boone loamy fine sands, 2 to 6 percent slopes.	Cc	IVs-2	Residuum from sandstone	Somewhat excessive	Very dark grayish brown to dark grayish brown.	Yellowish brown.
Chelsea and Boone loamy fine sands, slightly or moderately eroded, 7 to 11 percent slopes.	Cd	IVs-3	Residuum from sandstone	Excessive	Same	Yellowish brown.
Chelsea and Boone loamy fine sands, 12 to 17 percent slopes.	Ce	VIIs-1	Residuum from sandstone	Excessive	Same	Yellowish brown.
Chelsea and Boone loamy fine sands, 18 to 35 percent slopes.	Cf	VIIs-1	Residuum from sandstone	Excessive	Dark gray	Yellowish brown.
Clyde silty clay loam	Cg	IIIw-1	Iowan glacial till	Very poor	Black	Olive gray.
Clyde silty clay loam, overwash	Ch	IIIw-1	Iowan glacial till	Very poor	Very dark grayish brown to black.	Olive gray.
Dakota fine sandy loam, shallow, 0 to 1 percent slopes.	Da	IIIs-1	Moderately coarse textured material underlain by stratified sand and gravel.	Somewhat excessive	Very dark gray	Dark yellowish brown.
Dakota fine sandy loam, shallow, 2 to 6 percent slopes.	Db	IIIs-1	Same	Somewhat excessive	Very dark gray	Dark yellowish brown.
Dakota fine sandy loam, eroded, shallow, 2 to 6 percent slopes.	Dc	IIIs-1	Same	Somewhat excessive	Very dark grayish brown	Dark yellowish brown.
Dakota fine sandy loam, eroded, shallow, 12 to 17 percent slopes.	Dd	VIIs-1	Same	Somewhat excessive	Very dark grayish brown	Dark yellowish brown
Dakota loam, 0 to 1 percent slopes	De	IIe-3	Medium textured material underlain by stratified sands and gravel.	Good	Very dark brown	Dark yellowish brown.
Dakota loam, 2 to 6 percent slopes	Df	IIe-3	Same	Good	Very dark brown	Dark yellowish brown.
Dickinson fine sandy loam, 0 to 6 percent slopes.	Dg	IIIs-1	Sorted glacial drift: stratified sands.	Somewhat excessive	Very dark grayish brown	Dark yellowish brown.
Dickinson fine sandy loam, eroded, 2 to 6 percent slopes.	Dh	IIIs-1	Same	Somewhat excessive	Very dark grayish brown	Dark yellowish brown.
Dickinson fine sandy loam, eroded, 7 to 11 percent slopes.	Dk	IVs-1	Same	Somewhat excessive	Dark grayish brown	Dark yellowish brown.
Dickinson fine sandy loam, moderately deep, 2 to 6 percent slopes.	Dl	IIIs-1	Sorted glacial drift: stratified sands underlain by fine material.	Good	Very dark brown	Dark yellowish brown.
Dickinson fine sandy loam, moderately deep, eroded, 2 to 6 percent slopes.	Dm	IIIs-1	Same	Good	Very dark brown	Dark yellowish brown.
Dickinson fine sandy loam, moderately deep, eroded, 7 to 11 percent slopes.	Dn	IVs-1	Same	Somewhat excessive	Dark brown	Dark yellowish brown.
Dickinson loam, 2 to 6 percent slopes.	Do	IIe-3	Sorted glacial drift: stratified sands.	Good	Very dark grayish brown	Dark brown.
Dickinson loam, eroded, 2 to 6 percent slopes.	Dp	IIe-3	Same	Good	Very dark grayish brown	Dark brown.
Dickinson loam, eroded, 7 to 11 percent slopes.	Dr	IVe-1	Same	Good	Dark brown	Dark brown.

Summary of important soil characteristics—Continued

Soil	Map symbol	Capability unit	Parent material	Drainage	Color (moist)	
					Surface soil	Subsoil
Dubuque and Whalan silt loams, shallow, 2 to 6 percent slopes.	Ds	IIIe-2	Thin deposits of loess and residuum from limestone (Dubuque). Glacial till and residuum from limestone (Whalan).	Good	Dark gray to very dark gray.	Strong brown.
Dubuque and Whalan silt loams, shallow, eroded, 2 to 6 percent slopes.	Dt	IIIe-2	Same	Good	Same	Strong brown.
Dubuque and Whalan silt loams, shallow, eroded, 7 to 11 percent slopes.	Du	IVe-2	Same	Good	Same	Strong brown.
Dubuque and Whalan silt loams, shallow, slightly or moderately eroded, 12 to 17 percent slopes.	Dv	VIe-1	Same	Good	Brown	Reddish brown.
Dubuque and Whalan silt loams, shallow, severely eroded, 12 to 17 percent slopes.	Dw	VIIe-1	Same	Good	Brown	Reddish brown.
Dubuque and Whalan silt loams, shallow, 18 to 45 percent slopes.	Dx	VIIe-1	Same	Somewhat excessive	Brown	Reddish brown.
Escarpments	Ea	VIIs-1	Variable: loose sand or gravel.	Excessive	Variable	Variable.
Fayette silt loam, 0 to 1 percent slopes.	Fa	I-1	Silty Peorian loess	Good	Very dark gray	Dark brown.
Fayette silt loam, 2 to 6 percent slopes.	Fb	IIe-2	Silty Peorian loess	Good	Very dark gray	Dark brown.
Fayette silt loam, eroded, 2 to 6 percent slopes.	Fc	IIe-2	Silty Peorian loess	Good	Very dark grayish brown	Dark yellowish brown.
Fayette silt loam, eroded, 7 to 11 percent slopes.	Fd	IIIe-1	Silty Peorian loess	Good	Very dark grayish brown	Dark yellowish brown.
Fayette silt loam, severely eroded, 7 to 11 percent slopes.	Fe	IVe-1	Silty Peorian loess	Good	Dark brown	Dark yellowish brown.
Fayette silt loam, eroded, 12 to 17 percent slopes.	Ff	IVe-1	Silty Peorian loess	Good	Dark brown	Dark yellowish brown.
Fayette silt loam, severely eroded, 12 to 17 percent slopes.	Fg	VIe-1	Silty Peorian loess	Good	Dark brown	Dark yellowish brown.
Fayette silt loam, slightly or moderately eroded, 18 to 45 percent slopes.	Fh	VIIe-1	Silty Peorian loess	Somewhat excessive	Dark brown	Dark yellowish brown.
Fayette silt loam, terrace, 2 to 6 percent slopes.	Fk	IIe-2	Silty Peorian loess over sands.	Good	Very dark gray	Yellowish brown.
Fayette silt loam, terrace, eroded, 2 to 6 percent slopes.	Fl	IIe-2	Same	Good	Very dark grayish brown	Yellowish brown.
Fayette silt loam, terrace, eroded, 7 to 17 percent slopes.	Fm	IIIe-1	Same	Good	Very dark grayish brown	Dark yellowish brown.
Floyd and Clyde silty clay loams, overwash, 0 to 3 percent slopes.	Fn	IIw-2	Iowan glacial till	Somewhat poor to poor	Black	Grayish brown.
Hixton fine sandy loam, slightly or moderately eroded, 2 to 11 percent slopes.	Ha	IVs-1	Residuum from sandstone: stratified sandy colluvium.	Somewhat excessive	Very dark gray	Dark brown.
Hixton fine sandy loam, slightly or moderately eroded, 12 to 35 percent slopes.	Hb	VIIs-1	Same	Excessive	Very dark grayish brown	Dark brown.
Kasson silt loam, 0 to 1 percent slopes.	Ka	IIe-1	Thin loess mantle over Iowan glacial till (deeply leached clay loam).	Moderately good	Very dark gray	Light olive brown.
Kasson silt loam, 2 to 6 percent slopes.	Kb	IIe-1	Same	Moderately good	Very dark gray	Light olive brown.

Summary of important soil characteristics—Continued

Soil	Map symbol	Capability unit	Parent material	Drainage	Color (moist)	
					Surface soil	Subsoil
Kato silty clay loam	Kc	IIw-2	Moderate fine textured material underlain by stratified sand and gravel.	Poor	Black	Olive brown.
Kenyon silt loam, 0 to 1 percent slopes.	Kd	I-1	Thin loess mantle over Iowan glacial till (clay loam).	Moderately good	Very dark gray to black	Yellowish brown.
Kenyon silt loam, 2 to 6 percent slopes.	Ke	IIe-1	Thin loess mantle over Iowan glacial till (clay loam).	Moderately good	Very dark gray to black	Yellowish brown.
Lindstrom silt loam and fine sandy loam, 2 to 6 percent slopes.	La	IIe-1	Dark-colored silty colluvium over sands.	Good	Very dark gray to black	Dark brown.
Lindstrom silt loam and fine sandy loam, 7 to 11 percent slopes.	Lb	IIIe-1	Same	Good	Very dark gray to black	Dark brown.
Lindstrom silt loam and fine sandy loam, slightly or moderately eroded, 12 to 17 percent slopes.	Lc	IVe-1	Same	Somewhat excessive	Very dark gray	Dark brown.
Lindstrom silt loam and fine sandy loam, 18 to 45 percent slopes.	Ld	VIIe-1	Same	Somewhat excessive	Very dark gray	Dark brown.
Marshan silty clay loam	Ma	IIIw-1	Moderately fine textured material underlain by sand and gravel.	Very poor	Black	Olive brown.
Meridian fine sandy loam, 0 to 1 percent slopes.	Mb	IIIs-1	Stratified sands and gravel	Good	Very dark gray	Dark brown.
Meridian fine sandy loam, slightly or moderately eroded, 2 to 6 percent slopes.	Mc	IIIs-1	Stratified sands and gravel	Good	Very dark gray	Dark brown.
Mixed alluvial land, 0 to 6 percent slopes.	Md	VIw-1	Variable	Variable: subject to overflow.	Variable	Variable.
Mixed alluvial land, 7 to 17 percent slopes.	Me	VIIs-1	Variable: often stony	Same	Variable	Variable.
Plainfield and Sparta loamy fine sands, slightly or moderately eroded, 2 to 6 percent slopes.	Pa	IVs-2	Stratified sandy material, dominantly quartz.	Excessive	Dark gray to dark grayish brown.	Light yellowish brown.
Plainfield and Sparta loamy fine sands, eroded, 7 to 11 percent slopes.	Pb	IVs-3	Same	Excessive	Same	Light yellowish brown.
Peat and Muck	Pc	IIIw-4	Plant remains	Very poor	Black	Very dark brown.
Racine and Ostrander silt loams and loams, 0 to 1 percent slopes.	Ra	I-1	Iowan glacial till (clay loam).	Good	Dark gray to very dark gray (Ostrander), lighter-colored (Racine).	Brown to yellowish brown.
Racine and Ostrander silt loams and loams, 2 to 6 percent slopes.	Rb	IIe-1	Iowan glacial till (clay loam).	Good	Same	Brown to yellowish brown.
Racine and Ostrander silt loams and loams, eroded, 2 to 6 percent slopes.	Rc	IIe-1	Iowan glacial till (clay loam).	Good	Dark grayish brown to brown.	Brown to yellowish brown.
Racine and Ostrander silt loams and loams, eroded, 7 to 11 percent slopes.	Rd	IIIe-1	Iowan glacial till (clay loam).	Good	Same	Brown to yellowish brown.
Racine and Ostrander silt loams and loams, eroded, 12 to 17 percent slopes.	Re	IVe-1	Iowan glacial till (clay loam).	Good	Same	Brown to yellowish brown.
Renova silt loam and loam, 0 to 1 percent slopes.	Rf	I-1	Iowan glacial till (clay loam).	Good	Grayish brown	Dark brown to dark yellowish brown.
Renova silt loam and loam, 2 to 6 percent slopes.	Rg	IIe-2	Iowan glacial till (clay loam).	Good	Grayish brown	Same.
Renova silt loam and loam, eroded, 2 to 6 percent slopes.	Rh	IIe-2	Iowan glacial till (clay loam).	Good	Grayish brown	Same.
Renova silt loam and loam, eroded, 7 to 11 percent slopes.	Rk	IIIe-1	Iowan glacial till (clay loam).	Good	Dark brown	Yellowish brown.

Summary of important soil characteristics—Continued

Soil	Map symbol	Capability unit	Parent material	Drainage	Color (moist)	
					Surface soil	Subsoil
Renova silt loam and loam, eroded, 12 to 17 percent slopes.	Rl	IVe-1	Iowan glacial till (clay loam).	Good	Dark brown	Yellowish brown.
Rockton and Dodgeville silt loams, shallow, 2 to 6 percent slopes.	Rm	IIIe-2	Thin Iowan glacial till (Rockton) loess (Dodgeville) and residuum from limestone.	Moderately good to good	Dark gray to very dark gray.	Dark yellowish brown.
Rockton and Dodgeville silt loams, shallow, eroded, 2 to 6 percent slopes.	Rn	IIIe-2	Same	Moderately good to good	Very dark grayish brown	Dark yellowish brown.
Rockton and Dodgeville silt loams, shallow, eroded, 7 to 11 percent slopes.	Ro	IVe-2	Same	Moderately good to good	Very dark grayish brown	Yellowish brown.
Rockton and Dodgeville silt loams, shallow, eroded, 12 to 17 percent slopes.	Rp	VIe-1	Same	Moderately good to good	Very dark grayish brown	Strong brown.
Rockton and Dodgeville silt loams, shallow, 18 to 35 percent slopes.	Rr	VIIe-1	Same	Somewhat excessive	Very dark grayish brown to brown.	Strong brown.
Schapville silt loam and silty clay loam, 2 to 6 percent slopes.	Sa	IIIw-5	Thin loess and residuum from shale.	Moderately good	Very dark gray	Olive.
Schapville silt loam and silty clay loam, 7 to 11 percent slopes.	Sb	IVe-2	Same	Good	Very dark gray	Olive.
Schapville silt loam and silty clay loam, slightly or moderately eroded, 12 to 17 percent slopes.	Sc	VIe-1	Same	Good	Very dark grayish brown	Light olive brown.
Seaton and Port Byron silt loams, eroded, 2 to 6 percent slopes.	Sd	IIe-2	Coarse-textured Peorian loess.	Good	Very dark grayish brown to dark gray.	Brown to yellowish brown.
Seaton and Port Byron silt loams, eroded, 7 to 11 percent slopes.	Se	IIIe-1	Coarse-textured Peorian loess.	Good	Same	Brown to yellowish brown.
Seaton and Port Byron silt loams, eroded, 12 to 17 percent slopes.	Sf	IVe-1	Coarse-textured Peorian loess.	Somewhat excessive	Same	Brown to yellowish brown.
Skyberg silt loam, 0 to 3 percent slopes.	Sg	IIIw-2	Thin loess mantle over deeply leached, firm, Iowan glacial till.	Somewhat poor	Very dark grayish brown	Grayish brown.
Sogn silt loam, 0 to 6 percent slopes	Sh	IVe-2	Very thin loess and till, and residuum from limestone and shale.	Good	Very dark grayish brown	Olive brown.
Sogn silt loam, eroded, 7 to 11 percent slopes.	Sk	VIe-1	Same	Somewhat excessive	Very dark grayish brown	Olive brown.
Steep rocky land	Sl	VIIe-1	Variable: commonly rock fragments and outcrops.	Excessive	Variable	Variable.
Tama and Downs silt loams, 0 to 1 percent slopes.	Ta	I-1	Silty Peorian loess	Good	Very dark gray to dark gray.	Dark brown.
Tama and Downs silt loams, 2 to 6 percent slopes.	Tb	IIe-1	Silty Peorian loess	Good	Same	Dark brown.
Tama and Downs silt loams, eroded, 2 to 6 percent slopes.	Tc	IIe-1	Silty Peorian loess	Good	Same	Dark brown.
Tama and Downs silt loams, 7 to 11 percent slopes.	Td	IIIe-1	Silty Peorian loess	Good	Same	Dark brown.
Tama and Downs silt loams, eroded, 7 to 11 percent slopes.	Te	IIIe-1	Silty Peorian loess	Good	Very dark grayish brown	Dark yellowish brown.
Tama and Downs silt loams, 12 to 17 percent slopes.	Tf	IVe-1	Silty Peorian loess	Good	Very dark grayish brown	Dark yellowish brown.
Tama and Downs silt loams, eroded, 12 to 17 percent slopes.	Tg	IVe-1	Silty Peorian loess	Good	Brown	Dark yellowish brown.
Tama and Downs silt loams, severely eroded, 12 to 17 percent slopes.	Th	VIe-1	Silty Peorian loess	Good	Brown	Dark yellowish brown.
Tama and Downs silt loams, 18 to 35 percent slopes.	Tk	VIe-1	Silty Peorian loess	Good	Brown	Dark yellowish brown.

Summary of important soil characteristics—Continued

Soil	Map symbol	Capability unit	Parent material	Drainage	Color (moist)	
					Surface soil	Subsoil
Thurston and Wykoff loams, moderately deep, 0 to 1 percent slopes.	Tl	IIe-3	Sorted glacial drift, and stratified sand and gravel.	Somewhat excessive	Dark gray to grayish brown.	Dark yellowish brown.
Thurston and Wykoff loams, moderately deep, eroded, 2 to 6 percent slopes.	Tm	IIe-3	Same	Somewhat excessive	Same	Dark yellowish brown.
Thurston and Wykoff loams, moderately deep, eroded, 7 to 17 percent slopes.	Tn	IVe-1	Same	Somewhat excessive	Dark grayish brown to brown.	Dark yellowish brown.
Thurston and Wykoff sandy loams, shallow, 0 to 1 percent slopes.	To	IIIs-1	Same	Somewhat excessive	Dark grayish brown to brown.	Yellowish brown.
Thurston and Wykoff sandy loams, shallow, eroded, 2 to 6 percent slopes.	Tp	IIIs-1	Same	Somewhat excessive	Very dark grayish brown to brown.	Yellowish brown.
Thurston and Wykoff sandy loams, shallow, eroded, 7 to 11 percent slopes.	Tr	IVs-1	Same	Somewhat excessive	Same	Yellowish brown.
Waukegan silt loam, 0 to 1 percent slopes.	Wa	I-1	Silty material underlain by stratified sand and gravel.	Good	Black to very dark brown	Brown to yellowish brown.
Waukegan silt loam, 2 to 6 percent slopes.	Wb	IIe-1	Same	Good	Same	Same.

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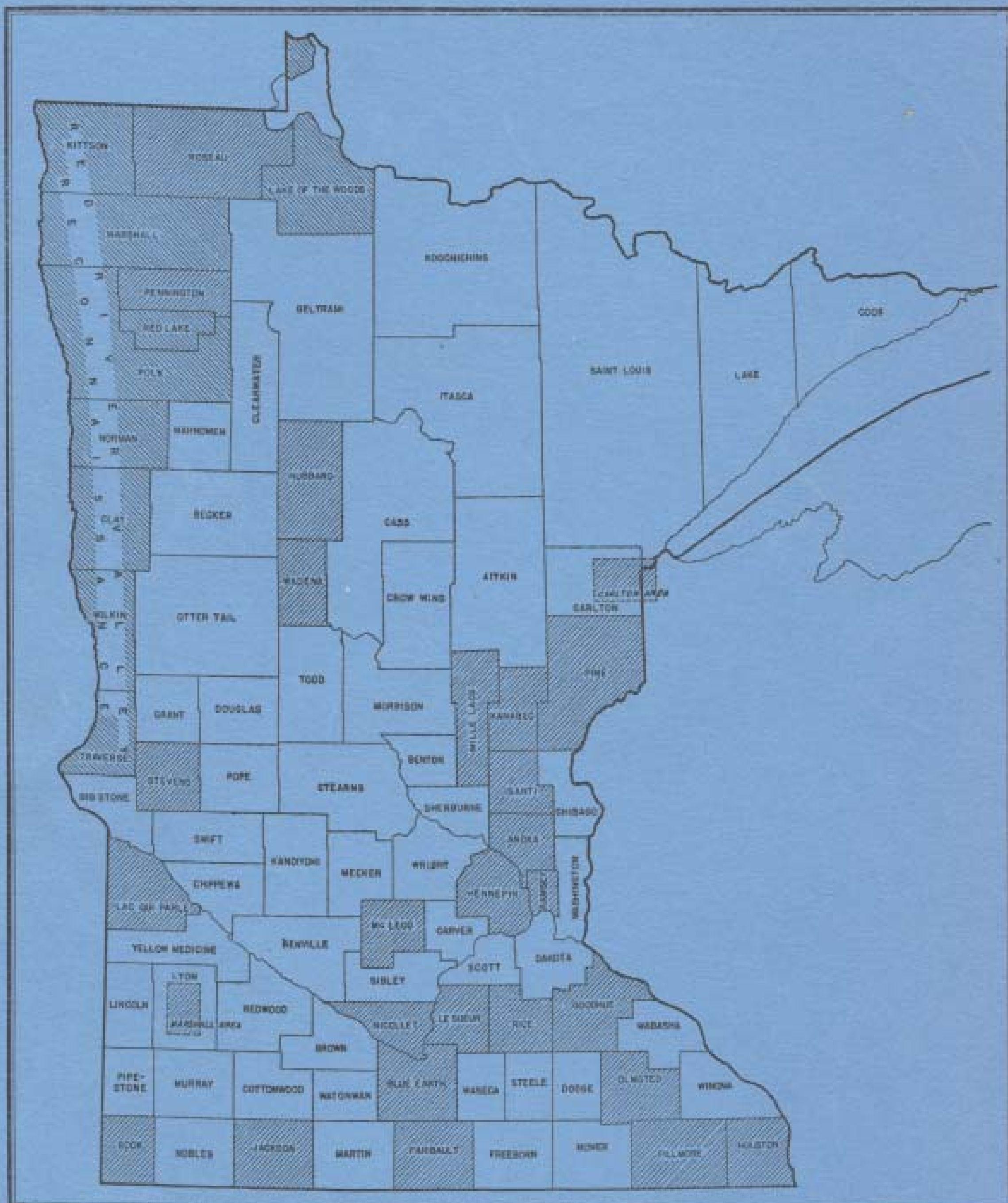

Areas surveyed in Minnesota shown by shading. Detailed surveys shown by northeast-southwest hatching; reconnaissance surveys by northwest-southeast hatching.

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